Weaving Calculations

C. P. Brooks

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COTTON YARN Wrapping Table for One, Three, or Four Leas.

Table IV. from C. P. Brooks' book on "Weaving Calculations." Price 5s.

A Handbook on all Calculations required in the Weaving and Preparatory Processes.

One Lea.		Counts.	Three Leas.		Four Leas.		One Lea.		Counts.	Three Leas.		Four Leas.		One Lea.		Counts.	Three Leas.		Four Leas.	
Dwt.	Grs.		Dwt.	Grs.	Dwt.	Grs.	Dwt.	Grs.		Dwt.	Grs.	Dwt.	Grs.	Dwt.	Grs.		Dwt.	Grs.	Dwt.	Grs.
	12¼	81·63	1	12¾	2	1	1	0½	40·81	3	1½	4	2	2	1	20·40	6	3	8	4
	12½	80·00	1	13	2	2	1	1	40·00	3	3	4	4	2	2	20·00	6	6	8	8
	12¾	78·43	1	14¼	2	3	1	1½	39·21	3	4½	4	6	2	3	19·60	6	9	8	12
	13	76·92	1	15	2	4	1	2	38·46	3	6	4	8	2	4	19·23	6	12	8	16
	13¼	75·47	1	15¾	2	5	1	2½	37·73	3	7½	4	10	2	5	18·86	6	15	8	20
	13½	74·07	1	16½	2	6	1	3	37·03	3	9	4	12	2	6	18·51	6	18	9	0
	13¾	72·72	1	17¼	2	7	1	3½	36·36	3	10½	4	14	2	7	18·18	6	21	9	4
	14	71·42	1	18	2	8	1	4	35·71	3	12	4	16	2	8	17·85	7	0	9	8
	14¼	70·17	1	18¾	2	9	1	4½	35·08	3	13½	4	18	2	9	17·54	7	3	9	12
	14½	68·96	1	19½	2	10	1	5	34·48	3	15	4	20	2	10	17·24	7	6	9	15
	14¾	67·79	1	20¼	2	11	1	5½	33·89	3	16½	4	22	2	11	16·94	7	9	9	20
	15	66·66	1	21	2	12	1	6	33·33	3	18	5	0	2	12	16·66	7	12	10	0
	15¼	65·57	1	21¾	2	13	1	6½	32·78	3	19½	5	2	2	13	16·39	7	15	10	4
	15½	64·51	1	22½	2	14	1	7	32·25	3	21	5	4	2	14	16·12	7	18	10	8
	15¾	63·49	1	23¼	2	15	1	7½	31·74	3	22½	5	6	2	15	15·87	7	21	10	12
	16	62·50	2	0	2	16	1	8	31·25	4	0	5	8	2	16	15·62	8	0	10	16
	16¼	61·53	2	0¾	2	17	1	8½	30·76	4	1½	5	10	2	17	15·38	8	3	10	20
	16½	60·60	2	1½	2	18	1	9	30·30	4	3	5	12	2	18	15·15	8	6	11	0
	17	58·82	2	3	2	20	1	10	29·41	4	6	5	16	2	20	14·70	8	12	11	8

	17	58·82	2	3	2	20	1	10	29·41	4	0	5	10	2	20	14·70	8	12	11	8
	17¼	57·97	2	3¾	2	21	1	10½	28·98	4	7½	5	18	2	21	14·49	8	15	11	12
	17½	57·14	2	4½	2	22	1	11	28·57	4	9	5	20	2	22	14·28	8	18	11	16
	17¾	56·33	2	5¼	2	23	1	11½	28·16	4	10½	5	22	2	23	14·08	8	21	11	20
	18	55·55	2	6	3	0	1	12	27·77	4	12	6	0	3	0	13·88	9	0	12	0
	18¼	54·79	2	6¾	3	1	1	12½	27·39	4	13½	6	2	3	2	13·51	9	6	12	8
	18½	54·05	2	7½	3	2	1	13	27·02	4	15	6	4	3	4	13·15	9	12	12	16
	18¾	53·33	2	8¼	3	3	1	13½	26·66	4	16½	6	6	3	6	12·82	9	18	13	0
	19	52·63	2	9	3	4	1	14	26·31	4	18	6	8	3	8	12·50	10	0	13	8
	19¼	51·93	2	9¾	3	5	1	14½	25·97	4	19½	6	10	3	10	12·19	10	6	13	16
	19½	51·28	2	10½	3	6	1	15	25·64	4	21	6	12	3	12	11·90	10	12	14	0
	19¾	50·63	2	11¼	3	7	1	15½	25·31	4	22½	6	14	3	14	11·62	10	18	14	8
	20	50·00	2	12	3	8	1	16	25·00	5	0	6	16	3	16	11·36	11	0	14	16
	20¼	49·38	2	12¾	3	9	1	16½	24·69	5	1½	6	18	3	18	11·11	11	6	15	0
	20½	48·78	2	13½	3	10	1	17	24·39	5	3	6	20	3	20	10·86	11	12	15	8
	20¾	48·19	2	14¼	3	11	1	17½	24·09	5	4½	6	22	3	22	10·63	11	18	15	16
	21	47·61	2	15	3	12	1	18	23·80	5	6	7	0	4	0	10·41	12	0	16	0
	21¼	47·05	2	15¾	3	13	1	18½	23·52	5	7½	7	2	4	4	10·00	12	12	16	16
	21½	46·51	2	16½	3	14	1	19	23·25	5	9	7	4	4	8	9·61	13	0	17	8
	21¾	45·97	2	17¼	3	15	1	19½	22·98	5	10½	7	6	4	12	9·25	13	12	18	0
	22	45·45	2	18	3	16	1	20	22·72	5	12	7	8	4	16	8·92	14	0	18	16
	22¼	44·94	2	18¾	3	17	1	20½	22·47	5	13½	7	10	4	20	8·62	14	12	19	8
	22½	44·44	2	19½	3	18	1	21	22·22	5	15	7	12	5	0	8·33	15	0	20	0
	22¾	43·95	2	20¼	3	19	1	21½	21·97	5	16½	7	14	5	4	8·06	15	12	20	16
	23	43·47	2	21	3	20	1	22	21·73	5	18	7	16	5	8	7·81	16	0	21	8
	23¼	43·01	2	21¾	3	21	1	22½	21·50	5	19½	7	18	5	12	7·57	16	12	22	0
	23½	42·55	2	22½	3	22	1	23	21·27	5	21	7	20	5	16	7·35	17	0	22	16
	23¾	42·10	2	23¼	3	23	1	23½	21·05	5	22½	7	22	5	20	7·14	17	12	23	8
1	0	41·66	3	0	4	0	2	0	20·83	6	0	8	0	6	0	6·94	18	0	24	0

THIRD EDITION.

Cloth, crown 8vo, 6s.

COTTON MANUFACTURING.

By the Same Author.

EIGHTY ILLUSTRATIONS.

A complete Treatise on the Machinery, Processes, and Products of Cotton Weaving.

C. C Canfield.
Feb. 1898.

WEAVING CALCULATIONS.

A GUIDE TO CALCULATIONS RELATING TO COTTON YARN AND CLOTH AND ALL PROCESSES OF COTTON WEAVING.

BY

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AUTHOR OF "COTTON MANUFACTURING;"

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ILLUSTRATED.

LONDON: E. & F. N. SPON, 125 STRAND.
AND NEW YORK: 12 CORTLANDT STREET.
MANCHESTER: C. P. BROOKS, HARPURHEY.
JOHN HEYWOOD, DEANSGATE AND RIDGEFIELD.
1893.

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1893
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Gift of Mr. Clifford C. Crawfield
Nov. 1953

PREFACE TO FIRST EDITION.

MANY books have in times past been published by authors whose object has been to explain the calculations of the weaving industries. This was more frequently the case in the earlier days of the trade than it has been in recent times, the first forty or fifty years of this century being prolific in this respect, some indeed being published even in the last century. The author has in his possession one dating so far back as 1779. The cause of so many works being published early in this century is explained by the fact that seventy to eighty years ago the introduction of power machinery was taking place rapidly, and the trade was consequently in a transition stage. Doubtless there would be much inquiry, and information would be in great demand on the subject of calculations connected with the trade and necessary for use. Thus books descriptive of the machinery, coupling with this the calculations, supplied the demand.

However, few, if any books exclusively on cotton weaving calculations have been published for twenty or thirty years, and the author, believing that such a one is wanted, publishes the present work to replace those which in their time have done good service to the manufacturing interests of their day, but which are now out

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of date. The object in the production of this book has been to tabulate and collect the various calculations and rules which from time to time are required in the manufacturing industries, to adapt them for reference and for instruction.

The author has endeavoured to provide a book of calculations, and not of descriptive explanation of machinery. For this the reader is referred to various books of his and other authorship. It has been borne in mind that such a book as the present one will have many readers among the younger members of the trade, and therefore the explanations and examples have been given at some length, and with as great simplicity as possible. For this reason intricate explanations, such as necessitate algebraical and other of the deeper classes of mathematics, have been avoided, for such are only passed over by the practical manufacturer, who desires simplicity and clearness, and which tend to encourage the common opinion, formed not without reason, that technical education in some directions tends too much towards theory.

It is probable that some rules have been omitted referring to special branches of trade or systems of calculation with which the author may not be acquainted. Should any reader notice this, a communication from him will be gladly accepted.

C. P. Brooks

BLACKBURN, *July* 1889.

PREFACE TO SECOND EDITION.

IN preparing the second edition for the press the author heartily thanks his numerous correspondents for their examination, their corrections, their criticisms, and their suggestions regarding the first edition. All these were welcome, and have aided in making this edition still more comprehensive and useful than its predecessor. In this edition many rules and examples have been added, several parts of the book have been rewritten, and further exercises from the City and Guilds' examination papers introduced. Recent alterations in standard wage lists necessitated the addition of three new ones, including the important Uniform List, which is given in full, with explanations and examples. Other sections which have been added to are those relating to coloured cloth, yarn tables, warping calculations, and details of commercial usages. The author has still endeavoured to retain the clear and simple style of explanation which characterised the first edition, knowing that it is preferred by many students of the leading textile industry. He hopes that this edition will meet with the same approbation as was shown to the former one in an extensive circulation and by the many correspondents.

C. W. S.

MANCHESTER, *February* 1893.

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Weaving Calculations.

CLOTH CALCULATIONS.

THESE are by far the most important to the textile manufacturer. It is to them that he must refer in settling the price that he shall receive for his work; on their accuracy in indicating the weight of twist or of weft that he shall give for a certain price, or the length or counts of yarn he shall use, a great deal of his success depends, and thus the maker of cotton goods endeavours to deduce with exactitude and nicety the amount necessary to repay him for the material, labour, and expense to which he is put in producing a piece of cloth. No two manufacturers work on exactly the same terms, conditions, classes of fabrics, and rate of expense, and therefore each has to adopt rules best adapted to his own position and requirements, and no rule can be given which shall be binding to all. These facts preclude the possibility of framing hard and fast rules, but doubtless a few generalities will be found acceptable to many readers.

To obtain the Weight of Twist required for a piece of cloth many methods are employed to suit particular

classes of fabrics on which people are engaged, but all systems can be traced to one common to each.

Rule A.—*Multiply the number of ends of twist by the length of warp from which the piece is made, divide this result by the number of yards in a hank, and also by the counts of yarn used.*

It will be clearly seen that by this means a comparatively accurate result will be obtained. The number of ends or threads of twist multiplied by the length of warp required, obviously includes the whole of the twist in the piece in yards, and the division by the number of hanks and counts is made simply for the purpose of converting length into weight. The counts or numbers of cotton yarn mean the number of hanks contained in a pound, and 840 yards make a hank. A fuller explanation of this is given in the section on yarn calculations.

Ends in a Piece.—Firstly, we must arrive at the number of ends in the piece of cloth by

Rule B.—*Multiply the width in the reed by the number of ends in an inch of reed.*

The width in the reed is usually an inch or two wider than the cloth, and no arbitrary rule can be made by which the reed width can be obtained. It will be sufficient for our purpose if we take it at 5 per cent. more than the cloth width; for wide light cloths it would probably suffice, but for narrow ones 5 per cent. on the width would hardly be enough to allow, and the latter remark also applies to the heavily picked or heavily wefted fabrics.

Example.—Forty-inch cloth made with a 56 reed, say

5 per cent. added to 40 = 40 + 2 = 42 inches[1] in the reed multiplied by 56 =

$$\begin{array}{r} 42 \\ 56 \\ \hline 252 \\ 210 \\ \hline 2352 \end{array}$$ ends required.

This gives us the first requirement of the Rule A. We now want the length of warp.

It will be noted that no mention has been made of selvage ends or twisters. At the side of a piece of cloth the warp threads are laid together more closely to form a strong border, and thus a few extra ends are required to keep up the width. The number can only be exactly estimated by practice. In the case given, probably 32 would be required, 16 for each side. The number necessary is greater where the cloth has to come up full width, or over-width, where coarse weft is used, or where the cloth is heavily picked. Fewer selvage ends will suffice where thin picks, fine weft, bastard reeds, &c., are used. The weighting of the beam, and the make and setting of the temples, also affect the number to be allowed. Usually it is customary to give 20 ends at each side, or a modification of this according to the class of the cloth. Often two-fold yarn is used for selvages, and in this case no number need be allowed for selvage ends, but it must be borne in mind that 20 ends or so at each side are double ones, and each end calculated as two in getting the weight out.

It may be stated that many practical manufacturers, in calculating for quotation purposes, do not trouble to add

[1] For an explanation of the signs used, and also of various arithmetical rules, see section on arithmetical rules and explanations.

the selvage ends as such, as it rather complicates the calculation, and trust to the allowance they make for contraction on the width, or the fact of the twist stretching and becoming finer during working, to cover the selvage ends. For this reason, the reader will note the omission in most of the following examples.

However, in putting orders into work and getting out the necessary particulars, such as the ends for warping, it is absolutely necessary to consider them.

Length of Warp.—Different names are given to this, such as cut length, tape length, slashing length; but they all mean the length of twist used for a piece of cloth. This is longer than the piece itself, because of the

Contraction or Milling up which takes place during weaving. The thread bends round the weft to a small extent, and if removed after having been woven would appear slightly wavy, and, of course, in that form occupies a shorter length than would a straight thread. It is difficult to give a hard and fast scale for this milling up, which, along with the allowance for extra ends, varies greatly with the class of cloth made, counts used, the class of looms employed, the weather, or the system of sizing.

The author has at various times made many experiments and gone to considerable trouble in endeavouring to deduce formulæ, based on accurate mathematical principles, that shall apply to contraction correctly in all varieties of cloths, and has seen the same attempted in various publications, but in all cases unsuccessfully. The causes named above upset the most well-formed theories, and nothing but practical observation applied in repeat orders can be thoroughly successful. It is possible, however, to arrive at approximate rules for medium plain cloth only.

One **Rule C** *for ascertaining the contraction is to multiply the picks in a quarter of an inch by* 12 *and divide by the counts of weft.*

This, apart from the differences caused by the local circumstances just mentioned, is comparatively accurate for counts of twist and weft from 25's to 50's, and picks from 10 to 20 to the quarter inch. For higher picks 13 must be taken as the multiplier. A table framed on the above rule would be as under:—

Table I.—Approximate Percentage of Contraction in Warps.

Picks per Quarter Inch.	Counts of Weft.				
	24's.	30's.	36's.	42's.	48's.
10	5	4	$3\frac{1}{3}$	$2\frac{6}{7}$	$2\frac{1}{2}$
12	6	$4\frac{4}{5}$	4	$3\frac{3}{7}$	3
14	7	$5\frac{3}{5}$	$4\frac{2}{3}$	4	$3\frac{1}{2}$
16	8	$6\frac{2}{5}$	$5\frac{1}{3}$	$4\frac{4}{7}$	4
18	9	$7\frac{1}{5}$	6	$5\frac{1}{7}$	$4\frac{1}{2}$
20	10	8	$6\frac{2}{3}$	$5\frac{5}{7}$	5

Or in decimals—a more convenient method:—

Picks per Quarter Inch.	Counts of Weft.				
	24's.	30's.	36's.	42's.	48's.
10	5	4.0	3·33	2.85	2.5
12	6	4.8	4.00	3·43	3.0
14	7	5.6	4.66	4.0	3·5
16	8	6.4	5·33	4·57	4.0
18	9	7.2	6.00	5.14	4.5
20	10	8.0	6.66	5·71	5.0

Example.—Supposing we made a 90-yard piece with 42's weft and 14 pick. The table allows 4 per cent., then we should slash it 93 yards 22 inches, 3 yards 22 inches being 4 per cent.[1] on 90 yards.

Another rule—a useful one from its simplicity—is :—

Rule C1.—*Multiply the length in yards of piece required by the picks per inch, and divide by the counts of weft. The answer is the number of inches that should be allowed.*

This rule does not bring the cloth out quite as long as the Rule C, but, with this exception, is quite as reliable for a limited range of counts and picks.

Example.—A piece is required to be $17\frac{1}{2}$ yards long, 12 picks of 42's weft per quarter inch, $17\frac{1}{2}$ yards × 48 picks per inch divided by 42's gives 20 inches to allow. Thus the warp length would be 18 yards 2 inches.

Ans. 18 yards 2 inches.

All the remarks on contraction on the preceding pages must be understood to refer to getting bare lengths on medium makes of plain cloth only. There is a great variety in the allowances that have to be made for contraction in fancy goods. A twill ground cloth requires much less allowance than a plain; and some others, where the warp only interweaves at comparatively distant points, such as 8 end satins, hardly take up at all. On the other hand, certain threads in such cloths as crimps, leno, and other gauze fabrics, and in some quiltings, towellings, and piques, take up so much that the high percentage of contraction necessitates their being woven from separate beams, as there are two and even three beams at one loom.

The counts of the warp yarn also make a considerable

[1] For an explanation of percentage, see section on arithmetical rules and explanations.

difference; 20's twist, for example, contracts more quickly than 32's.

As a matter of fact, although we add a certain percentage to the length that we intend the cloth to be, in order to ascertain the length of warp, the contraction does not take place on the cloth length, but on the warp length. Thus, if there is 10 per cent. *actual* contraction on a certain piece of cloth which is required to be 100 yards in length, 10 per cent. on 100 would not suffice. Ten per cent. added to 100 is 110. Ten per cent. contraction on 110 yards is $110 \times 10 \div 100 = 11$ yards, which would only leave 99 yards of cloth.

This is the reason why 13 has to be taken as multiplier on heavier picked cloth instead of 12. The allowance for contraction increases in greater proportion than the increase of picks. The reader, however, will find a sufficient percentage of allowance in Table I., if taken on the cloth length only.

There has now sufficient explanation been given for us to apply the Rule A.

Example.—Take a 40-inch 75-yard cloth, made with 60 reed, 30's twist, and 36's weft—15 picks to the quarter inch.

Add 5 per cent. to the width $= 40 + 2 = 42$ inches.

$$\begin{array}{r} 42 \text{ width.} \\ 60 \\ \hline 2520 \text{ ends required.} \end{array}$$

The rate of contraction according to Rule C. is $12 \times 15 \div 36 = 5$ per cent.

75 yards + 5 per cent.

75 + 3 yards and 27 inches = 78 yards 27 inches,

which is the length of warp.

2520 × 78 yards 27 inches = 198450 yards twist.

We have now to divide by 840 (yards to a hank) and by the counts of twist (30's).

840)198450(236¼
1680
3045
2520
5250
5040
210
210/840 = ¼

30)236¼(7 lbs. 14 oz.
210
26¼
16
4
156
26
420(14
30
120
120

Ans. 7 lbs. 14 oz.

Weight of Weft.

To find the weight of weft in a piece.

Rule D.—*Multiply the width in the reed by the picks in an inch, and by the length in yards of the piece when woven, and divide by the counts of weft and the number of yards in a hank.*

The explanation that has been given before about the width at which the twist stands in the reed applies to the above rule for the weft. It is necessary to take this width, which is wider than the cloth actually measures, in consequence of the weft contracting in a waved line, thus ~~~~~~~~~~~~~~, just as we have explained regarding the twist.

There is an apparent omission in the above rule in stating:—Multiply the picks in an *inch* by the width,

and then by the length in yards. We ought really to multiply by 36 to get the number of picks in a yard, but then we should have a result in inches, because we took the width of cloth in inches, so instead of multiplying by 36 and dividing also by 36, we take the result as being in yards. Thus, if the yarn in the reed is 40 inches and picks per inch 60, we get $40 \times 60 = 2400$ inches of weft in an inch of cloth, which is taken as 2400 yards of weft in a yard of cloth. Thus 2400×36 inches = 86,400, and divided by 36 to reduce it to yards gives 2400 yards, which is the same result.

Example.—For the length the actual number of yards on the counter is taken. Thus, for a cloth 40 inches wide, 75 yards long, 36's weft, 15 picks to the quarter inch, the quantity of weft is obtained as under:—

```
Width in reed      42 inches
Picks in 1 inch    60
                 ----
                 2520
Length             75
                 ----
                12600
               17640
               -----
840 yds.)189000(225 hanks
            1680
            ----
             2100
             1680
            ----
             4200
             4200
            ----
36's weft)225(6 lbs. 4 ozs.
          216
          ---
            9
           16 ozs.
          ---
          144
          144
```

Ans. 6 lbs. 4 ozs.

Reeds and Wheels Necessary for Various Cloths.—At pages 169 and 97 are given tables showing the right reeds and wheels suitable for giving various numbers of ends and picks to the quarter inch.

Scotch System of Calculating Weights.

The Scotch system of numbering reeds and picks would necessitate rather different procedure from the foregoing. It would be described as a 40-inch, 75 yards, 11°° reed, 11 shots on the glass, 30's twist, and 36's weft.

11°° reed means 1100 dents or splits on 37 inches, *i.e.*, 2200 ends. As the warp is 42 inches wide at the reed, we get the ends by multiplying 2200 by 42 and dividing by 37, thus arriving at 2498 ends. To get the weight of twist, follow our previous Rule A.

$2498 \times 78\frac{3}{4}$ yards $\div$ 840 and 30.

2498
$78\frac{3}{4}$
19984
17486
1249
624

840)196717(234$\frac{1}{5}$
1680
2871
2520
3517
3360
157

$\frac{157}{840}$ about $\frac{1}{5}$

Ans. 7 lbs. $12\frac{9}{10}$ oz.

30)234$\frac{1}{5}$(7 lbs. $12\frac{9}{10}$ ozs.
210
$24\frac{1}{5}$
16
3
144
24
387
30
87
60
27

$\frac{27}{30} = \frac{9}{10}$

Shots on the glass means picks in the Scotch glass of $\frac{1}{200}$ part of 37 inches.

Rule E.—*To get weft weight then we take width* × *shots on glass* × 200, *divide by* 37 *to reduce result to yards, by counts and by yards in a hank.*

Example.

$42 \times 11 \times 200 \times 75 \div 37$ and 36's and 840.

Ans. 6.19 lbs.

Weight of Yarn in Stripe Cloth.—In many fabrics the yarn is not evenly distributed over the surface of the cloth, but arranged in stripe form. Suppose, for instance, the example previously given (40-inch, 75 yards, 60 reed, 15 picks, 36's weft) had alternate stripes of 1 inch 60 reed 2 in a dent, 30's twist, and $\frac{1}{2}$ inch 60 reed 4 in a dent, 40's twist, ending at each side with the stripe of 30's twist.

Then there would be 39 inches of alternate stripes. 39 divided by the space of two stripes ($1\frac{1}{2}$ inches) gives 26 stripes of 40's twist and 26 of 30's twist. Add one stripe to the 30's twist for the extra one at the side, making 27. To get the ends of 30's twist add the contraction, 5 per cent., to the number 60, that being the ends in an inch of reed, 60 + 5 per cent. = 63; there are 27 stripes, therefore there are $63 \times 27 = 1701$ ends. The rule previously given for getting the weight of twist is now taken, and we get $1701 \times 78\frac{3}{4} \div 840$ and 30 = 5 lbs. $5\frac{1}{8}$ ozs.

Then there are 26 stripes of 40's twist. Half inch of 60 reed 4 in a dent gives 60 ends + 5 per cent. = 63×26 stripes = 1638 ends. $1638 \times 78\frac{3}{4} \div 840$ and 40 = 3 lbs. $13\frac{1}{2}$ ozs.

Rule F.—*To obtain weight of warp yarn for striped goods, we obtain the number of stripes of each colour or*

counts, and the ends in each stripe, add the contraction to the ends in each stripe, and multiply by the number of stripes.

The result is the number of ends, when the previous Rule A. can be followed. The same plan must be adopted for each sort of stripe in the piece.

We have just considered cloths in which the arrangement of the twist varies, and may now calculate for the differentiation of the weft in the same manner.

Example.—Take a satin stripe cloth to be made with 24 picks of plain followed by 36 picks satin. In the plain, the ratchet to take up as usual, but in the satin there are to be two picks of weft for one tooth taken up. The cloth to be 32 inches wide, 82 yards long, 32's/40's, 17 picks per quarter where plain. Find the average picks of weft and the weight of weft per piece.

Rule G.—*Find the average picks per inch, and proceed as in an ordinary calculation.*

In a yard of cloth woven 17 picks to the quarter there should be $17 \times 4 \times 36 = 2448$ picks.

In the above cloth 36 picks of satin take up the space of 18 plain. There are also 24 plain, so the double stripe occupies the space of 42 picks.

$42)2448(58\frac{2}{7}$ stripes in a yard.

210

348

336

12 picks extra in each satin stripe.

$\frac{12}{42} = \frac{2}{7}$

18 multiplied by $58\frac{2}{7} = 1049\frac{1}{7}$

added to 2448

$3497\frac{1}{7}$

$3497\frac{1}{7}$ picks per yard, averaging $97\frac{1}{7}$ picks per inch.

Adopting Rule D.—

$$34 \times 97\tfrac{1}{7} \times 82 \div 40\text{'s} \times 840 = 8.06 \text{ lbs.}$$

Ans. Average picks, $97\frac{1}{7}$; weight weft, 8.06 lbs.

Coloured Checks and Stripes.—In the weaving of coloured goods, such as ginghams, oxfords, harvards, flannelettes, the ordinary rules given are almost always required, in a modified form, in costing or rating the goods, and also in getting out the particulars with which to put the cloth in work, both necessitating the separate weights of each different colour and counts.

Rule H.—*When there are different colours of warp in the one cloth, apply Rules A. and B., but divide the weight in proportion to the number of ends of each colour in the warp plan. When there are different colours of weft of the same counts, work out the weight by Rule D., but apportion it according to the picking plan. If the various colours are also different in counts, it must be apportioned when the number of hanks have been ascertained.*

Example.—Find the particulars of each colour in a piece of cloth 32 inches wide, 80 yards long, 58 reed, 16 pick, 24's twist, 18's red weft, 16's white weft, 18's blue weft, allowing 90 yards of warp, and 5 per cent. for waste.

Woven	2 red	
	4 white	
	2 blue	
	4 white	
	4 blue	Warped the same.
	2 white	
	4 blue	
	4 white	
	2 blue	
	4 white	
	32 picks.	

In the colour plan out of every 32 ends, there are 2 red, 18 white, 12 blue.

Warp.—34 inches × 58 reed, allowing 28 for selvage, gives 2000 ends.

Of these, 2	out of 32	would be	red	=	125 ends.
18	,,	,,	white	=	1125 ,,
12	,,	,,	blue	=	750 ,,
					2000 ,,

To get the weight of warp apply Rule A.—

$$\frac{1125 \times 90}{840 \times 24} = 5.022$$

$$\frac{125 \times 90}{840 \times 24} = .558$$

$$\frac{750 \times 90}{840 \times 24} = 3.348$$

$$8.928 \text{ lbs.}$$

The calculation could have been made—

$$\frac{2000 \times 90}{840 \times 24} = 8.928 \text{ lbs.}$$

and the weight apportioned, but in this case the separate ends for each warp would not have been obtained, and as it is necessary to have these, in order to make separate warps to dye to the different colours, the mode given is best. If white selvages are required, a little less weight of red and blue will be used, and correspondingly more white.

Weft.—Apply Rule D.—

$$\frac{34 \times 80 \times 64}{840} = 207.24 \text{ hanks of weft used}$$

	207.24
Add waste, 5 per cent.	10.36
Total hanks required,	217.6

The picks are in the proportion of 2 red, 18 white, and 12 blue, the same as in the warp.

Out of every thirty-two hanks,—

two are red equalling 13.6 hanks, divided by the counts 18's	= .755
eighteen are white equalling 122.4 hanks, divided by the counts 16's	= 7.65
twelve are blue equalling 81.6 hanks, divided by the counts 18's	= 4.54
	lbs. 12.94

Had all the weft been one counts, say 16's, the best plan would have been to work the calculation—

$$\frac{34 \times 80 \times 64}{840 \times 16} = 12.95$$

Add 5 % waste .65

13.6

$\frac{2}{32}$ or $\frac{1}{16}$ of this is red	= .85
$\frac{18}{32}$ or $\frac{9}{16}$ of this is white	= 7.65
$\frac{12}{32}$ or $\frac{3}{8}$ of this is blue	= 5.1
	13.6

After calculating the weight of warp and weft at the market prices, the additions to these figures are then made for dyeing the warp at the usual price for each colour, dressing the warp, drawing or twisting it, and all other wages and expenses. The total is divided by the length of cloth on counter, to give the unfinished price per yard. Where the goods are delivered finished, then an addition has to be made for the specific finishing process that it has to go through, or in the case of flannelettes, for raising, &c. Divided by the finished length, which is longer than the grey length, we obtain the finished price per yard. Many coloured manufacturers get out tables of prices per piece

or per yard to cover all these extras, and save themselves considerable trouble in calculation.

All the preceding calculations are for cotton goods. Should other materials be used, we must divide by a different number of yards in the hank in each case. We give 840 for cotton; for worsted we should take 560, for linen 300, and for single silk 840. (See section on Yarn Calculations.)

Length of Yarn in Cloth.

Rule J.—*To get the length of twist in a piece of cloth, multiply number of ends by length of warp.*

Rule K.—*To get length of weft in a piece of cloth, multiply width in reed in inches by picks in* 1 *inch, and by length of piece when woven.*

Counts to give Certain Weights.—In many instances it is necessary to arrive at the counts of yarn necessary to give a certain weight of cloth, the width, length, reed, pick, and weight being given.

Rule L.—*Find the length of yarn in the piece, reduce it to hanks, and divide this by the weight in pounds. The result will be the average counts of twist and weft.*

Example.—Take a piece 60 inch, 40 yards, 50 reed, 12 picks, to be 6 lbs. Length of *twist* (Rule J), 60 + 5 per cent. = 63 inches at reed. 40 yards plus say 5 per cent. for milling up = 42 yards.

$$63 \times 50 \times 42$$

$$\begin{array}{r} 3150 \\ 42 \\ \hline 6300 \\ 12600 \\ \hline 132300 \end{array}$$ yards twist.

Weft (Rule K).—63 × 48 picks × 40 yards =

63
48
504
252
3024

3024
40
120960 yards weft.

Length twist = 132300
„ weft = 120960

840)253260(301½ hanks
2520
1260
840
420

6 lbs.)301½(50¼'s yarn
30
1½

Should this be too fine for the twist and too coarse for the weft, as, for instance, when it is desirable to use 40's twist, the method adopted is to calculate the weight of 40's twist required, and deduct this from the 6 lbs., and from the balance the counts of weft can be obtained thus—

132300 yards of 40's twist weigh $\frac{132300}{840 \times 40} = 3$ lbs. 15 ozs.,
then the weft weighs 2 lbs. 1 oz.
120960 yards of weft = 144 hanks.
144 hanks divided by 2 lbs. 1 oz. = 69.8 counts weft.

To find Weight of a Piece from a Small Sample.—It is frequently necessary in the cotton cloth trade to estimate the weight or price of a piece of cloth from a small sample. This may be done either by comparing

different pieces of known counts of yarn, reed, and pick with the sample until an exactly similar one be found, or another system is to pick out certain lengths of threads, if the size of the sample will allow, and wrap them as will be described. The weight of a piece can, however, be calculated almost exactly from a small sample, and thus a method of ascertaining the weight is obtained which can be used either with the previously mentioned ones as a check or independently.

Rule M.—*Multiply the weight in grains of the small sample by the number of square inches in a yard of the required cloth, and divide by the number of square inches in the sample and* $437\frac{1}{2}$. *The answer is the weight in ounces of one yard of the required cloth.*

Example.—A piece of cloth 3 inches by $1\frac{1}{2}$ inches weighs 10 grains. What will be the weight of a yard, and also the weight of a $37\frac{1}{2}$ yard piece 40 inches wide? Thus a yard contains $40 \times 36 = 1440$ square inches. The number of square inches in the pattern is $3 \times 1\frac{1}{2} = 4\frac{1}{2}$.

Multiply 1440 by 10 and divide by $4\frac{1}{2}$ and $437\frac{1}{2}$ gives 7.314 ozs. as the weight of a yard. 7.314 multiplied by $37\frac{1}{2}$ yards and divided by the number of ounces in a lb. (16) gives the weight per piece, 17.142 lbs.

Ans. 7.314 ozs.; 17.142 lbs.

There is now in use, to a considerable extent, a yarn assorting balance adapted for ascertaining the counts of small samples of yarn such as can be extracted from small pieces of cloth. It is Staub's balance, and the mode of operation is to cut a small square out of the cloth exactly the size of a little brass templet supplied with

the instrument. Each of the pieces of weft in this scrap are of course of the same length, and the balance is so arranged that the number of threads that turn the scale indicates the counts. Thus 32 threads would indicate 32's counts. The same thing applies to the warp threads out of the same sample, excepting that an allowance has to be made for the weight of size.

The reader will readily understand the principle of this machine when he calls to mind the fact that if an ordinary pair of scales were used with a 1 lb. weight at one end and a number of knots of yarn at the other, each being exactly one hank or 840 yards in length, it is clear that the counts of the yarn would be shown by the number of knots that balanced the 1 lb. weight. This principle is adopted in Staub's balance, the necessary modifications required in such a delicate balance, dealing with such minute weights, being made. It is surprising that such accurate results are obtained with the instrument in question when the fact of the normal variation of yarn counts is considered.

Costing, Rating, or Quoting for Cloth.—The object of all the preceding calculations, or at least the principal use of them, is to prepare for ascertaining the cost of the fabric. Whether the weight of the warp be obtained by applying Rules A. and B. or by Rule F., or the weight of the weft by Rules D. or E. or G., whether from full particulars provided, or from a scrap pattern, the prime cost per piece or per yard is usually desired. The weight of twist is taken at the market price, the weight of weft calculated at the same, the price for weaving calculated by one or other of the systems described in a later portion of this book, and then remains the allowances

that have to be made for winding, warping, sizing, wages, management expenses, coal, taxes, rent, oil, belting, carriage, commission, discount, and the scores of other expenses appertaining to the manufacture of cloth. It is of course impossible to calculate the exact amount to allow for each of these items for every different piece of cloth, or even to consider them separately, while a customer may be waiting on 'Change or at the telephone for the price. It is therefore not unusual to consider for an ordinary make of plain fabric that all these expenses are covered if a sum is added equal to the amount paid for weaving the piece. Even this is not a hard and fast rule, as the state of the markets have to be taken into consideration.

Taking the cloth given in a previous example, viz. :—

40 inch, 75 yards, 60 reed, 15 picks per quarter, 30's twist, 36's weft.

Weight of warp as previously ascertained, 7.875 lbs. at 8d. .. .	63.00
Weight of weft, 6.25 lbs. at 8d. .	50.00
Weaving wage, by uniform list less 10 per cent.	20.25
Estimate for expenses, one weaving wage	20.25
	153·50 or 12s. 9½d.

The total of these gives the price for a 75 yard piece of cloth. As explained under the heading of coloured goods, the price of the cloth has sometimes to be given in a finished state and per yard. In other goods, especially those of fancy weave, extras have to be added for expenses over and above ordinary cloths, such as special warping,

special heading, card cutting, harness mounting or tieing up, coloured borders, extra sizing, and many other expenses. Most manufacturers lay themselves out for certain classes of goods, and thus can tell to a nicety what to allow for such extras to suit their own position and circumstances.

Percentage of Size Required.—Sizing the warp is necessary in weaving single yarn, and it is often desirable to fix beforehand the percentage of size, so as not to put on too much or too little.

Suppose a 38 inch, $37\frac{1}{2}$ yards, 72 reed by 17 picks, 30's/40's has to weigh 8 lbs., and we desire to ascertain the percentage of size.

By the Rule A., previously given, the weight of twist is $40 \times 72 \times 39\frac{1}{2} \div 840 \times 30$, which gives $4\frac{1}{2}$ lbs. or thereabouts.

The weight of weft $= 40 \times 68 \times 37\frac{1}{2} \div 840 \times 40$ is 3 lbs. and $\frac{1}{2}$ oz.

4 lbs. 8 ozs. added to 3 lbs. $\frac{1}{2}$ oz. $= 7$ lbs. $8\frac{1}{2}$ ozs. Deduct this from 8 lbs. $= 7\frac{1}{2}$ ozs. of size on $4\frac{1}{2}$ lbs. of twist.

$4\frac{1}{2}$ lbs. = 72 ozs.)7.5 ozs.(10.41 per cent.

72

300

288

120

The standard makes of cotton cloth are fully described in the author's book on "Cotton Manufacturing."

Symmetry of Cloth.—In fabrics other than cotton it is necessary to utilise many calculations for the purpose of preserving a proper balance in their fabrication. In

the worsted trade especially, where few really plain fabrics are made, and where each cloth has some special feature caused either in design or colouring, or use of various counts or sorts of yarn, it is necessary to make ranges of cloth of a particular pattern, each being perfect in the relation of grist of yarn to closeness of sett, and yet varying in weight. It is necessary to change from one pattern of cloth to another, and calculate the counts of yarn or sett which shall give as firm a weave in the second cloth as the first, and sometimes this question of preserving the "balance of cloth" arises in using a new material to replace one previously used. In the cotton trade these questions seldom arise, the standard makes of cloth are made out of the same yarns, and if the question of forming a new fabric has to be contended with, patterns are easily made, often without much expense.

The majority of cotton fabrics do not depend for their utility on the nicety of selection of yarns and proportioning of grists and setts, such as do the worsted cloths, which have more important functions to perform; and we therefore do not give many formulæ for these calculations.

A thorough and comprehensive explanation of one part of this subject was given over forty years ago in a book by Murphy, and we cannot do better than reprint his remarks, altering the wording slightly to adapt it to modern necessities, and giving the Stockport counts of reed as an example instead of the Scotch system, such as he adopted.

Caaming, Sleying, or Setting.

"These terms are severally employed to denote the proportioning of the grists or fineness of warps to the different setts of reeds, so as to preserve a uniformity of fabric in the same species of cloth. In order to explain what is meant by the word fabric, let us suppose that a piece of cloth is woven in any sett of reed, as, for instance, a 60, and that the diameters of the warp threads and the small spaces between them are exactly of the same size. Then, if we have another piece of cloth of the same texture, woven, for example, in an 80 reed, the diameters of the warp threads being also equal to the intervening spaces, then these two sizes of cloth are said to be of the same fabric, although the one is a third finer than the other, so that, when the diameters of the threads are greater than the spaces, the fabric is proportionately stouter, and the reverse when they are smaller. Now, the method of determining the several grists of yarn that will preserve the uniformity of fabric through the different setts of reed depends on the following analogy:—

As the square of a given reed:
To the grist of yarn that suits that sett::
So is the square of any other sett of reed:
To its respective grist for the same fabric.

"The reason for this rule will evidently appear by considering the threads of warp when stretched in the loom as so many cylinders of equal length or altitude, and the reed as the scale which measures the space in which a given number of these threads are contained; therefore

the solidities of those in any sett of reed will be to the solidities of those in any other sett of reed as their bases, or, which is the same thing, as the squares of their diameters, by p. 11, b. 12 of Euclid. But the weights of the cylinders or threads, supposing them of the same density, will be as their solidities, and a determinate number of splits or dents of any reed, or rather the interval between them, may be substituted for the diameters of the warp threads which pass through them: therefore, by the last analogy, it will be as the square of the number of splits in any given reed to the known weight or grist of yarn, so is the square of any number of splits, occupying the same space, to the weight or grist of yarn that will produce cloth of the same fabric, which is the rule given above."

The rule may be expressed:—

Rule N.—*To find counts of yarn for a change of reed which shall suit the new reed as well as the first counts suited the old reed, multiply the reed of the new cloth squared by the counts of yarn in the old cloth, and divide by the square of the reed in the old cloth;* or what comes to the same, *multiply the reed of the new cloth by the square root of the counts of yarn in the old cloth, and divide by the reed in the old cloth. Square the result, and it gives the counts required.*

Example.—An example is found by supposing with 25's twist in a 60's reed that the space between the ends is equal to the diameter of the thread, and that we desire to find the yarn that should produce the same effect in a 70 reed.

As 60 squared is to 70 squared so 25's is to the result,

or 70 squared × 25's ÷ 60 squared gives the counts required.

The square of 70 = 4900
" " 60 = 3600

4900 × 25 = 122500

3600)122500(34$\frac{1}{36}$'s twist
10800
14500
14400
100

Using the alternative rule, square root of 25's × 70 ÷ 60 gives the square root of the result.

5 × 70 = 350
60)350(5$\frac{5}{6}$
300
50
60

The square of 5$\frac{5}{6}$ = 34$\frac{1}{36}$'s twist.

Ans. 34$\frac{1}{36}$'s.

The preceding rules are used *vice versâ* for finding suitable counts of reeds for different yarns, viz., to find a suitable reed in which to make a similar cloth to a given one but with different yarn.

Rule 0.—*Multiply the square of the given reed by the counts of the new yarn, and divide by the old yarn. Take the square root and you have the desired result; or multiply the given reed by the square root of the counts of the new yarn, and divide by the square root of the old yarn.*

Example.—A cloth is made with 60 reed and 25's

twist. What reed should be used with 16's twist to give a similar cloth ?

The square of $60 \times 16 \div 25 = 2304$. The square root of $2304 = 48$ reed

or

The square root of $16 \times 60 \div$ the square root of $25 = 48$.

An example of changing the reed and pick for a change of pattern is given among the answers to examination questions, as is also a change of yarns to give an equally firm cloth in a twill as in a plain weave.

YARN CALCULATIONS.

FROM the earliest stage of the cotton industry it has been found necessary to have some method of indicating the thickness of cotton threads, and there has gradually been built up a table indicating this by weight, a system which seems to be common to the whole of the British cotton trade. 840 yards are taken as a hank, and the number of hanks contained in a pound avoirdupois of 7000 grains is known variously as the counts, grist, size, or numbers of cotton yarn. Thus 20's has 840 × 20 = 16,800 yards in a lb. A yarn that has 52 × 840 yards in a lb. is called 52's. The thinner the thread the higher it is numbered. The numbers or counts signify the number of times that the yarn is finer than 1's.

The complete **Table (II.) of Measurement** is—

1½	yards	= 1	thread or circumference of a wrap reel.
120	,,	= 80 threads	= 1 lea.
840	,,	= 560 threads	= 7 leas = 1 HANK.

The Table of Weights is a peculiar one, being a pound avoirdupois divided into the troy weight denominations of pennyweights and ounces.

Table III.

24	grains	= 1 dwt.	
437½	,,	= 18 11/48 dwt.	= 1 oz.
7000	,,	= 291⅔ ,,	= 16 oz. = 1 lb.

The first line only of the table is used.

The system just described applies both to twist and weft.

Wrapping Yarn.—The practical way of testing the counts of yarn is to wind on a wrap reel 120 yards of yarn and weigh this, dividing its weight in grains into 1000. Thus the thinner a thread is, the less it will weigh, and therefore a higher count is got by dividing this smaller weight in grains into the number given.

A short explanation is necessary as to the manner in which we get at the number 1000.

1's yarn contains 1 hank in 1 lb.,

therefore it contains 840 yards in 7000 grains,

or one-seventh of this, 120 „ in 1000 „

As 840 yards would be too much to wrap, we take one-seventh of the length and also one-seventh of the corresponding weight as a standard.

10's yarn is ten times as fine as 1's, and 120 yards of it weigh 100 grains.

1000 divided by 100 = 10's counts.

We should only get the same result if we took 840 yards, which would weigh 700 grains divided into the weight of 840 yards of 1's, *i.e.*, 7000 grains, we get 7000 ÷ 700 = ten times as fine as 1's or 10's counts.

Rule A.—*To find the counts, wrap* 120 *yards, weigh it, and divide the weight in grains into* 1000.

Example.—Should 120 yards of yarn be wrapped and found to weigh 25 grains, then 1000 ÷ 25 = 40's. More than one cop might be taken, and the leas weighed together. Suppose 4 cops are wrapped, 1 lea or 120 yards off each, and found to weigh 3 dwts. and 8 grains,

four times 1000 must be taken as the dividend, that is 4000.

3 dwts. 8 grains = 80)4000(50's counts.
4000

Table IV. is a comprehensive one giving the counts of all yarns from 7's to 80's, as shown by the weight of either one lea, three leas, or four leas. The table is self-explanatory, and the reader will easily see that if one lea is wrapped from either one cop, three cops, or four cops, and the weight ascertained in grains, a reference to Table IV. gives the exact counts worked out to two decimal places.

With each copy of this book is presented a copy of Table IV., printed in suitable form for mounting on cardboard, and hanging in a mill or other office for reference when wrapping yarn with the wrap reel.

Table IV.—Wrapping Table for One, Three, or Four Leas.

One Lea.		Counts.	Three Leas.		Four Leas.		One Lea.		Counts.	Three Leas.		Four Leas.		One Lea.		Counts.	Three Leas.		Four Leas.	
Dwt.	Grs.		Dwt.	Grs.	Dwt.	Grs.	Dwt.	Grs.		Dwt.	Grs.	Dwt.	Grs.	Dwt.	Grs.		Dwt.	Grs.	Dwt.	Grs.
	12¼	81·63	1	12¾	2	1	1	0½	40·81	3	1½	4	2	2	1	20·40	6	3	8	4
	12½	80·00	1	13½	2	2	1	1	40·00	3	3	4	4	2	2	20·00	6	6	8	8
	12¾	78·43	1	14¼	2	3	1	1½	39·21	3	4½	4	6	2	3	19·60	6	9	8	12
	13	76·92	1	15	2	4	1	2	38·46	3	6	4	8	2	4	19·23	6	12	8	16
	13¼	75·47	1	15¾	2	5	1	2½	37·73	3	7½	4	10	2	5	18·86	6	15	8	20
	13½	74·07	1	16½	2	6	1	3	37·03	3	9	4	12	2	6	18·51	6	18	9	0
	13¾	72·72	1	17¼	2	7	1	3½	36·36	3	10½	4	14	2	7	18·18	6	21	9	4
	14	71·42	1	18	2	8	1	4	35·71	3	12	4	16	2	8	17·85	7	0	9	8
	14¼	70·17	1	18¾	2	9	1	4½	35·08	3	13½	4	18	2	9	17·54	7	3	9	12
	14½	68·96	1	19½	2	10	1	5	34·48	3	15	4	20	2	10	17·24	7	6	9	15
	14¾	67·79	1	20¼	2	11	1	5½	33·89	3	16½	4	22	2	11	16·94	7	9	9	20
	15	66·66	1	21	2	12	1	6	33·33	3	18	5	0	2	12	16·66	7	12	10	0
	15¼	65·57	1	21¾	2	13	1	6½	32·78	3	19½	5	2	2	13	16·39	7	15	10	4
	15½	64·51	1	22½	2	14	1	7	32·25	3	21	5	4	2	14	16·12	7	18	10	8
	15¾	63·49	1	23¼	2	15	1	7½	31·74	3	22½	5	6	2	15	15·87	7	21	10	12
	16	62·50	2	0	2	16	1	8	31·25	4	0	5	8	2	16	15·62	8	0	10	16
	16¼	61·53	2	0¾	2	17	1	8½	30·76	4	1½	5	10	2	17	15·38	8	3	10	20
	16½	60·60	2	1½	2	18	1	9	30·30	4	3	5	12	2	18	15·15	8	6	11	0
	16¾	59·70	2	2¼	2	19	1	9½	29·85	4	4½	5	14	2	19	14·92	8	9	11	4
	17	58·82	2	3	2	20	1	10	29·41	4	6	5	16	2	20	14·70	8	12	11	8

	17¼	57·97	2	3¾	2	21	1	10½	28·98	4	7½	5	18	2	21	14·49	8	15	11	12
	17½	57·14	2	4½	2	22	1	11	28·57	4	9	5	20	2	22	14·28	8	18	11	16
	17¾	56·33	2	5¼	2	23	1	11½	28·16	4	10½	5	22	2	23	14·08	8	21	11	20
	18	55·55	2	6	3	0	1	12	27·77	4	12	6	0	3	0	13·88	9	0	12	0
	18¼	54·79	2	6¾	3	1	1	12½	27·39	4	13½	6	2	3	2	13·51	9	6	12	8
	18½	54·05	2	7½	3	2	1	13	27·02	4	15	6	4	3	4	13·15	9	12	12	16
	18¾	53·33	2	8¼	3	3	1	13½	26·66	4	16½	6	6	3	6	12·82	9	18	13	0
	19	52·63	2	9	3	4	1	14	26·31	4	18	6	8	3	8	12·50	10	0	13	8
	19¼	51·93	2	9¾	3	5	1	14½	25·97	4	19½	6	10	3	10	12·19	10	6	13	16
	19½	51·28	2	10½	3	6	1	15	25·64	4	21	6	12	3	12	11·90	10	12	14	0
	19¾	50·63	2	11¼	3	7	1	15½	25·31	4	22½	6	14	3	14	11·62	10	18	14	8
	20	50·00	2	12	3	8	1	16	25·00	5	0	6	16	3	16	11·36	11	0	14	16
	20¼	49·38	2	12¾	3	9	1	16½	24·69	5	1½	6	18	3	18	11·11	11	6	15	0
	20½	48·78	2	13½	3	10	1	17	24·39	5	3	6	20	3	20	10·86	11	12	15	8
	20¾	48·19	2	14¼	3	11	1	17½	24·09	5	4½	6	22	3	22	10·63	11	18	15	16
	21	47·61	2	15	3	12	1	18	23·80	5	6	7	0	4	0	10·41	12	0	16	0
	21¼	47·05	2	15¾	3	13	1	18½	23·52	5	7½	7	2	4	4	10·00	12	12	16	16
	21½	46·51	2	16½	3	14	1	19	23·25	5	9	7	4	4	8	9·61	13	0	17	8
	21¾	45·97	2	17¼	3	15	1	19½	22·98	5	10½	7	6	4	12	9·25	13	12	18	0
	22	45·45	2	18	3	16	1	20	22·72	5	12	7	8	4	16	8·92	14	0	18	16
	22¼	44·94	2	18¾	3	17	1	20½	22·47	5	13½	7	10	4	20	8·62	14	12	19	8
	22½	44·44	2	19½	3	18	1	21	22·22	5	15	7	12	5	0	8·33	15	0	20	0
	22¾	43·95	2	20¼	3	19	1	21½	21·97	5	16½	7	14	5	4	8·06	15	12	20	16
	23	43·47	2	21	3	20	1	22	21·73	5	18	7	16	5	8	7·81	16	0	21	8
	23¼	43·01	2	21¾	3	21	1	22½	21·50	5	19½	7	18	5	12	7·57	16	12	22	0
	23½	42·55	2	22½	3	22	1	23	21·27	5	21	7	20	5	16	7·35	17	0	22	16
	23¾	42·10	2	23¼	3	23	1	23½	21·05	5	22½	7	22	5	20	7·14	17	12	23	8
1	0	41·66	3	0	4	0	2	0	20·83	6	0	8	0	6	0	6·94	18	0	24	0

If other lengths are taken the following are the dividends :—

Table V.

480	yards or	4	leas	=	4000	grains	dividend.
240	,,	2	,,	=	2000	,,	,,
120	,,	1	,,	=	1000	,,	,,
60	,,	$\frac{1}{2}$	,,	=	500	,,	,,
40	,,	$\frac{1}{3}$	,,	=	333·3	,,	,,
30	,,	$\frac{1}{4}$	,,	=	250	,,	,,
20	,,	$\frac{1}{6}$	,,	=	166.6	,,	,,
15	,,	$\frac{1}{8}$	,,	=	125	,,	,,
10	,,	$\frac{1}{12}$	,,	=	83·3	,,	,,
8	,,	$\frac{1}{15}$	,,	=	66.6	,,	,,
6	,,	$\frac{1}{20}$	,,	=	50	,,	,,
4	,,	$\frac{1}{30}$	,,	=	33·3	,,	,,
3	,,	$\frac{1}{40}$	,,	=	25	,,	,,
2	,,	$\frac{1}{60}$	,,	=	16.6	,,	,,
1	,,	$\frac{1}{120}$	,,	=	8.3	,,	,,

Sometimes it is necessary to test the counts of yarn from a scrap of woven fabric, and as only a short length of thread can be got, the above table regarding the shorter lengths is useful.

Having the lengths and counts given, to find the weight :—

Rule B.—*Divide the length by* 840 *and by the counts.*

Example.—What is the weight of 9240 yards of 44's weft ?

9240 yards ÷ 840 = 11 hanks.

In the given counts 44 hanks weigh 1 lb., then 11 hanks weigh $\frac{11}{44}$, or $\frac{1}{4}$ of a lb.

Ans. $\frac{1}{4}$ of a lb.

Having the weight and counts given, to find the length :—

Rule C.—*Multiply the weight in pounds by* 840 *and by the counts.*

Example.—79 lbs. of 17's yarn are required for a warp. What is the total length ?

$$79 \times 17 \times 840$$

$$\begin{array}{r} 79 \\ 17 \\ \hline 553 \\ 79 \\ \hline 1343 \\ 840 \\ \hline 537^{2}0 \\ 10744 \\ \hline 1128120 \end{array}$$ yards.

In most districts except Lancashire single yarns are generally indicated by 1 before or after the counts—thus, 1/40's, 1/20's in wool or worsted districts; or, 40's/1, 20's/1 in silk districts.

Double Yarns (Cotton.)—Twofold yarns are numbered according to the single yarn counts—thus, 2/80's = two ends of 80's twined together, which would wrap 40's. Actually, to make the resultant count 40's the single yarn should be finer than 80's, because the twist put in the folded yarn contracts it in length and causes the twofold to be really coarser than would appear. However, neglecting this, suppose we twine one end of 40's and one of 20's, the counts would not be 15's, as a first glance would indicate, but 13.33. This can be proved by taking the weight of a lea of 40's = 25 grains,

and of 20's = 50 grains; total, 75. 75 divided into 1000 gives the counts as $13\frac{1}{3}$. Another is—

Rule D.—*Multiply the two counts together and divide by their sum*—

$$\frac{40 \times 20}{40 + 20} = \frac{800}{60} = 13\tfrac{1}{3}$$

It is seldom that two different counts are doubled together as mentioned above. Singles of the same counts make the best doubled yarn.

To find the counts which must be doubled with another to make a given count:—

Rule E.—*Multiply the two counts given and divide by their difference.*

To find counts of three or more folds of single yarn all of one count:—

Rule F.—*Divide the single counts by the number of folds* —thus, 3/300's = 100's, and 4/80's = 20's.

To find counts of threefold yarns each of different counts:—

Rule G.—*Take the weight of a lea of each, add them together, and divide into* 1000.

Example.—Threefold yarn of 40's, 80's, and 120's would be 21.81.

A lea of 40's = 25 grains.
,, 80's = $12\frac{1}{2}$,,
,, 120's = $8\frac{1}{3}$,,
$45\frac{5}{6}$

$$\frac{1000}{45\frac{5}{6}} = 21\tfrac{9}{11}\text{'s counts.}$$

or

Rule H.—*Take the highest count and divide it by each of the others and by itself, then divide the total of the quotients into the highest.*

Example.

$$120 \div 80 = 1.5$$
$$120 \div 40 = 3$$
$$120 \div 120 = 1$$
$$5.5 \qquad \frac{120}{5.5} = 21.81$$

From these rules the reader can easily deduce the rule for four or higher fold.

Scotch Numbering.—In Scotland the quantity of yarn is often expressed in spindles, hanks, and leas, and the yarn measure is an extension of the one previously given.

Table VI.

1½	yards	=	1	thread.							
120	,,	=	80	,,	=	1	skein.				
840	,,	=	560	,,	=	7	,,	=	1	hank.	
15120	,,	=	10800	,,	=	126	,,	=	18	,,	= 1 spindle.

Example.—80 lbs. of 40's twist would be 177 spindles, 14 hanks.

80 × 40 = 3200 hanks.

18)3200(177 spindles

18

140

126

140

126

14 hanks.

Gross.—Worsted yarns are occasionally sold by the gross hanks, *i.e.*, 144 hanks each 560 yards.

Counts in other Materials and Systems. — The cotton manufacturer has occasionally for some classes of cloth to deal with counts of silk, worsted, or linen, and some information on these points will not be superfluous.

Silk.—Single silk is numbered like cotton 840 yards to the hank, except for folded patent silk, when the first number indicates the actual counts—thus, 40's/2 means two threads of 80's, which actually wrap 40's, as already explained. This would in cotton be written 2/80's. 30/3 in silk means three threads of 90's.

Worsted is numbered exactly as cotton, excepting that the length of the worsted hank is 560 yards—thus, 30's worsted has 30×560 yards in a pound, while 30's cotton has 30×840 yards. Botany yarn is a variety of worsted. Worsted folded yarns are numbered 2/60's, that is two threads of worsted 60's.

Worsted. 80 yards = 1 wrap.
560 „ = 7 wraps = 1 hank.

The French Cotton Standard, or **Metrical System,** as largely used on the Continent of Europe, is 1000 metres in 500 grammes, which is called No. 1, equal to 992.4 yards in one pound—thus 1.181 in English would be 1's in French.

Rule J.—*To find the Metrical or French numbers divide the number of metres measured, by its weight in grammes, and by* 2.

Thus if 24 metres weigh 2 grammes $24 \div 2 = 12 \div 2 =$ No. 6.

Rule K.—*To convert French numbers into English counts multiply by* 1.18.

Rule L.—*To convert English counts into French numbers multiply by* 1.18.

Example.—What would English 59's be in French numbers?

$$59 \div 1.18 = \text{No. } \underline{50}.$$

American Systems.—In the United States, cotton yarns are counted the same as English, viz., 840 yards to the hank. Silk and worsted are also numbered as in England, to a great extent. In woollen yarns, the principal system is the "run system." There are 1600 yards in a "run," and the yarns are numbered according to the runs in a pound. Another, common to woollen yarns, is the "cut" system; here 300 yards equal one cut, and the number of cuts in a pound indicate the numbers of the yarn. Doubled yarns in the States are numbered as in England. Cotton, silk, and woollen folded yarns have the number of threads placed before the counts of the *single* yarn, as 2/20's, 3/60's, &c. In silk the counts of the *folded* yarn are first written, and then the number of threads comprising the folded yarn, as 10's/2, 20's/3.

Linen.—The linen standard, called the "lea," is 300 yards. The linen hank is 10 leas, or 3000 yards.

1 thread = $2\frac{1}{2}$ yards = 90 inches = 2 English ells.

1 lea or cut =				120	threads =	300	yds.
1 heer =	2	leas or cuts =		240	„ =	600	„
1 hank = 5 heers =	10	„	„ =	1200	„ =	3000	„
1 hesp =	24	„	„ =	2880	„ =	7200	„
1 spindle = 2 hesps =	48	„	„ =	5760	„ =	14400	„

Coarse linen and jute are reckoned by the weight of a spindle—thus, if 14400 yards weighs 4 lbs. it is 4 lb. counts.

Finer linen is reckoned by the number of leas to the pound = 40's linen has 40×300 yards = 12000 yards in a pound.

Wool.—The usual method of indicating woollen counts is by the number of yards in a dram, and as many yards as there are in a dram are called so many skein yarn—thus, 10 skein counts means 10 yards in a dram, and as 16 drams make one ounce, 16 ounces 1 lb., then the number of skeins $\times 16 \times 16$, *i.e.*, 256 = the number of yards in a pound; otherwise expressed, 1536 yards = 1 skein in a watern of 6 lbs. 10 skein yarn has 2560 yards in a pound. This is often called the "Leeds system," but is largely used elsewhere. As there are 256 drams in a pound, this system may be expressed as the number of times 256 yards are contained in one pound.

Several examples must now be given of finding the equivalent counts in the various systems. To convert counts of one system into those of another.

Rule M.—*Multiply the counts given by the length of the hank or lea used for that material, and divide by the length of the hank or lea in the desired system.*

Example.

Case I.—What counts of worsted are equivalent to 30's cotton?

$$30 \times 840 \div 560 = 45\text{'s worsted.}$$

Case II.—What counts of spun silk are equal to 80's cotton? The same, 80's.

Case III.—What counts of linen are equal to 20's cotton?

$$20 \times 840 \div 300 = 56\text{'s linen.}$$

Case IV.—What counts of cotton are equivalent to 90's worsted?

$$90 \times 560 \div 840 = 60\text{'s}.$$

Bundle Yarn.—Cotton yarn is often reeled and then made up into bundles, more especially for export and the home dyeing trade. Home trade bundles are usually 10 lbs. in weight, and the yarn in them is double cross reeled, often expressed XX hank. Two hanks, = 1680 yards, are reeled together; then 5 of these are twisted, making 10 hank knots. In fine numbers they may be twisted in tens, making 20 hank knots. In finding if there are the right number of heads showing at the straight end of the bundle, indicating the number of knots in the bundle, apply—

Rule N.—*Multiply the weight of the bundle by the counts, and divide by the number of hanks in each knot.*

Example.—How many heads would show at the end of a press bundle of 2/40's yarn, 10 lbs., made up in 10 hank knots?

$$10 \times 20\text{'s} \div 10 = 20$$

Ans. 20 heads.

Testing Yarns.—In addition to wrapping warp yarn to ascertain actual counts, it is frequently tested as to strength. The lea from the reel is placed between two hooks on a testing machine, and by a wheel, worm, and screw, the lower hook is moved downwards, increasing the tension on the yarn. By an index finger this tension is indicated on a face plate, and when the lea is broken the finger stops at the highest weight or strain that the yarn has stood. Below is a table, which will give a general idea of the comparative strength of mule

twists, having the standard turns in—*i.e.*, for the American cottons square root of counts multiplied by $3\frac{3}{4}$, and for Egyptian, square root multiplied by 3.606.

20's	American	cotton	= 80 lbs.
30's	,,	,,	= 54 ,,
40's	,,	,,	= 40 ,,
	Egyptian	,,	= 50 ,,
50's	American	,,	= 28 ,,
	Egyptian	,,	= 37 ,,
60's	,,	,,	= 30 ,,
70's	,,	,,	= 26 ,,

Diameters of Yarns.—In yarn the diameters of the threads do not vary inversely as the counts, but inversely as the square root of the counts. Thus, 16's is not four times as thick as 64's, but twice as thick, the square roots being four and eight respectively. To find the counts of a yarn that shall have any desired relation in thickness to another yarn, apply—

Rule O.—*Extract the square root of the counts of the given yarn, invert the terms of the proportion between the given and the desired yarns, and proceed as in proportion, squaring the result.*

Examples.—What yarn is one-sixth as thick as 25's, or, in other words, has one-sixth the diameter of 25's?

The square root of 25 is 5
The terms are 1 to $\frac{1}{6}$
inverted ,, $\frac{1}{6}$ to 1

then as $\frac{1}{6}$ is to 1 so 5 is to $\frac{1 \times 5}{\frac{1}{6}} = \frac{1 \times 5 \times 6}{1} = 30$

30 squared = 900's

Ans. 900's yarn is one-sixth the thickness of 25's.

Another example is given among the answers to examination questions.

Testing Dampness.—Another test of yarn is to ascertain the dampness. A sample is dried at a temperature of about 100° Fahr., and then allowed to cool to an ordinary temperature of say 60°.

This is necessary, because the higher temperature might drive away some of the natural moisture which all cottons contain, and which it should be allowed to regain. Suppose yarn weighing 40 lbs. at first, only scales 38 lbs. when the test is complete, then it has lost $100 \times 2 \div 40 = 5$ per cent. The manufacturer gets 95 lbs. really for every 100 lbs., so that yarn costing 8d. per lb. at first actually costs $8\frac{7}{16}$d., obtained by multiplying $100 \times 8 \div 95 = 8.421$d., or about $8\frac{7}{16}$.

COMMERCIAL NOTES.

MANCHESTER.—Yarns are usually sold for home trade, either $2\frac{1}{2}$ per cent. terms, 14 days' accounts, or 3 per cent. cash terms. This is when the business is done direct. In the first case $2\frac{1}{2}$ per cent. discount is allowed off the gross amount of the invoice, less coppers, payable in 14 days from date of invoice, on Tuesdays or Fridays only. The cash terms allow a discount of 3 per cent., but the account is due the Tuesday or Friday following the date of invoice. It is generally understood that goods are free on rail at Manchester. Where an agent is employed, the full agency terms are 1 per cent. for commission and $\frac{1}{2}$ per cent. for guaranteeing payment of the account.

BRADFORD terms are much longer than these. In cotton, yarns delivered before the 26th of one month are paid for on the 3rd Thursday of the following month, less $2\frac{1}{2}$ per cent. discount. Thus yarns sent on the 24th of April would be paid for on the 3rd Thursday in May. If on the 27th of April on the 3rd Thursday in June, or two months' credit. Agency terms, as arranged; usually rather higher than Manchester. Carriage is expected to be paid by the seller.

GLASGOW terms are somewhat similar to Bradford, but the discounts vary largely, $7\frac{1}{2}$ per cent. being generally allowed. The 20th of the month is generally the date for limiting accounts for payment in the following month.

BELFAST buyers take deliveries to account up to the 15th of one month, paying for them on the 4th of the next month, usually less 2½ per cent.

In Bradford, Belfast and Glasgow, after the times named above have expired, bills are occasionally given. There can be no doubt that the prompt terms of Manchester have added very much to the stability of its houses, to the good credit in which the cotton trade is usually held in commercial circles, and to the development of the trade.

Piece Goods.—In Manchester, terms are again very prompt. Where business is done direct, the terms usually are 2½ per cent. discount for payment in 7 days. Where an agent is employed and paid 1½ per cent. on the transaction for commission and guarantee, the manufacturer customarily gets prompt cash less 2½ per cent.

In Glasgow, London, Bradford and Belfast the terms are, like yarn terms, much longer; in fact the bulk of the business is done by accepting bills for some forward date.

WEIGHTS, MEASURES, AND MONEYS OF FOREIGN COUNTRIES

HAVING COMMERCIAL RELATIONS WITH THE TEXTILE DISTRICTS OF ENGLAND.

WEIGHTS.

The Metrical system of weights is the most common one, and at the same time the most sensible system. It is sometimes called the French system, and has been officially adopted in most cases for weights, measures, and moneys in Belgium, France, Germany, Italy, Portugal, Spain, Norway, Sweden, Austria, Bulgaria, Holland,

Switzerland, Chili, Argentine Republic, and the United States. In some cases the nomenclature has been altered and only the principle adopted; in other countries, where the use of the system has not been made compulsory, it has not yet got into common use.

1 gramme	=	the unit (15.432 grains).
10 grammes	=	1 décagramme.
100 ,,	=	1 hectogramme.
1000 ,,	=	1 kilogramme.
.1 or $\frac{1}{10}$,,	=	1 décigramme.
.01 or $\frac{1}{100}$,,	=	1 centigramme.
.001 or $\frac{1}{1000}$,,	=	1 milligramme.

One kilogramme is equal to 2.2046 lbs., or $35\frac{1}{4}$ oz. nearly.

China.—

1 leang or tael	=	.083 lbs. avoir.			
16 ,,	,, =	1.333	,,	=	1 kire or katty.
1600 ,,	,, =	133.33	,,	=	100 ,, ,,
				=	1 tan or pecul.

India.—The legal standards are the metrical ones of the kilogramme (2.2046 lbs.), called the legal seer; the metre (39.37 inches); the litre, also called the seer (1.76077 pints). The old systems, of which there are many in consequence of the large extent of the country, are still largely used.

In Bengal, 1 seer = 16 chittacks = 80 tolas = 2.057 lbs. (avoir.). 40 seers = 1 maund.

In Madras, the candy = 20 maunds of 40 seers each, the weight of the candy here being 493.71 lbs., is in use. By commercial usage the candy is still frequently taken at 500 lbs., and the maund at 25 lbs.

In Bombay there is still in use a candy of 20 maunds

of 4 seers each, equalling 560 lbs., the seer in this case being 7 lbs.

Egypt.—1 cantar = 98.046 lbs. (avoir.), and consists of 100 rottoli, each rottolo containing 12 uckreh or 96 meticals. 12 dirhem make 1 uckreh.

Japan.—1 rin = 10 mo = 1.33 lbs. (avoir.).

Brazil.—1 quintal (100 arratel) = 101.186 lbs. (avoir.).

United States.—The old English measures and weights generally adhered to, although the metrical system has been authorised.

MEASURES.

Metrical System. Linear Measure.

1	mètre	= the unit = 39.37 inches = 1.093 yds.
10	,,	= 1 décamètre.
100	,,	= 1 hectomètre.
1000	,,	= 1 kilomètre = .621 English mile.
.1 or $\frac{1}{10}$	,,	= 1 décimètre.
.01 or $\frac{1}{100}$	,,	= 1 centimètre = .3937 inch.
.001 or $\frac{1}{1000}$	,,	= 1 millimètre.

Brazil.—1 pollegada = 1.093 inches.
1 vara = 1.215 yards.

China.—Shanghai Customs chih = 14.098 inches.

Egypt.—1 kirat = 1.125 inches.

India.—Bengal. 1 guz = 1 yard.
1 moot = 3 inches.

Madras. 1 guz = 33 inches; English measures also used.

Bombay. 1 guz = 27 inches.
1 tussoo = 1.125 inches.

Also see under "Weights."

United States.—As in England.

Japan.—1 sun = 1.1954 inches.
10 „ = 1 shaku.
100 „ = 10 „ = 1 jo.

MONEYS.

France . .	100 centimes	= 1 franc,	about	9½d. Eng.
Italy . . .	100 centesimi	= 1 lire,	„	9½d. „
Switzerland	100 centimes	= 1 franc,	„	9½d. „
Belgium .	100 „	= 1 „	„	9½d. „
Spain . .	100 centimos	= 1 peseta,	„	9½d. „
Germany .	100 pfennige	= 1 mark,	„	12d. „

India.—Taking the rupee at 16d. sterling; nominal value 2/.

1 pice . . . . = .0833 English.
12 „ = 1 anna . . = 1d. „
192 „ = 16 annas = 1 rupee = 16d. „

China.—Taking the tael at 4/2; nominal value 6/6.

1 candarine . . . = .05d. English.
100 „ = 1 mace . = 5d. „
1000 „ = 10 „ = 1 tael = 50d. „

United States.—100 cents = 1 dollar ($) = 4/2 English.

SPEED AND GEARING CALCULATIONS.

BEFORE considering the calculations referring to the general cotton manufacturing machinery, it is advisable to mention a few fundamental rules which frequently are necessary to determine problems common to all kinds of mechanism. What rules are referred to in particular are those by which we calculate speeds of shafting, and these are given first.

To Determine the Speed of a driven Shaft.—When the speed of a driving shaft or wheel is given, and also the size of the gearing transmitting the power, to find the speed of driven shafts or wheels.

Rule A.—*Multiply the speed of the first driving shaft by the size of the driving wheel or wheels, and divide by the driven wheel or wheels.*

Example.—A line shaft in a shed revolves 150 times per minute, and carries pulleys 15 inches in diameter. The looms driven by them carry pulleys 10 inches in diameter. At what speed do the looms run? Multiply 150 by the driving wheel 15, and divide by 10.

Ans. 225 revolutions.

Cogs or Ropes.—The term "size of the wheel" in the rules includes either number of teeth, diameter, radius, or pitch circle, and refers equally to cog wheels, either

bevel or otherwise, or rope, or strap driving. A pair of mitre wheels are bevels whose teeth are equal in number, and therefore make no change in the speed, but reverse the direction of motion.

The method of description of the driving wheel necessarily must also be applied to the driven. For example, if the diameter of the driving wheel be taken, the diameter also of the driven one must be adopted, and neither the radius nor circumference.

Case I. Example.—The driving wheel of an engine revolving 50 times a minute is 30 feet in diameter, and by means of ropes drives a pulley on the second motion shaft of 3 feet in radius. What is the speed of the second motion shaft?

50 × 30 feet ÷ double the radius 6 = 250 revolutions per minute.

Case II.—The under shaft of a loom revolves 90 times a minute, and carries a bevel of 15 teeth, which gears with a 15 on an upright shaft. At the top of this shaft a 12 drives a 60-teeth wheel on a block of tappet plates. At what speed do they revolve?

90 × first driver, 15 × second driver, 12 ÷ first driven 15, and second driven 60.

Ans. 18 revolutions per minute.

To Determine which is the Driver or Driven Wheel is not difficult, a glance at the gearing when in motion usually shows it. The driver is generally bright or worn on the front of the tooth, *i.e.*, on the side of the tooth in the direction of which the wheel moves. If a wheel is worn on the side of the tooth further from the direction of its motion it is a driven wheel. Then with

bands and straps, one side of the band or strap is tighter than the other. That which is pulling can readily be recognised as the driver.

To find the Speed of the Driving Wheel, when the speed of the last driven wheel is known, and also the size of the gearing.

Rule B.—*Multiply the speed of the last driven wheel by the size of the driven wheels, and divide by the size of the drivers.*

Example.—A spindle is required to revolve 1000 times a minute, and the proposed method is to drive it from a line shaft by a 40-inch drum to a 15-inch pulley, the latter being fixed to a 10-inch tin roller driving the $1\frac{1}{4}$ inch wharve on the spindle. At what speed will the line shaft have to revolve? The drivers are 40 and 10, the driven 15 and $1\frac{1}{4}$.

$$1000 \times 15 \times 1\tfrac{1}{4} = 18750$$

$$40)18750$$

$$10)468\tfrac{3}{4}$$

$46\frac{7}{8}$ revolutions per minute.

To obtain the Size of the Driving Wheel, if the speed of the driven and driving shaft are given along with the size of the driven pulleys.

Rule C.—*Multiply the speed of the driven by the size of the driven pulleys, and divide by the speed of the driver.*

Example.—A shaft, speed 100 per minute, drives another at 70 per minute; on the latter is a 50-tooth bevel wheel. What size of a bevel wheel is on the driving-shaft?

Multiply $70 \times 50 \div 100 = 35$ teeth.

To obtain the Size of the Driven Wheel, if the speed of the driver and driven wheel or wheels are given along with the size of the driver.

Rule D.—*Multiply the size of the drivers by speed of first driver, and divide by the speed of driven, and by the driven pulleys given, if any.*

Example.—A shaft making 17 revolutions per minute carries a 16-tooth wheel driving a second shaft by means of a wheel the number of teeth in which it is desired to find. On this shaft is a 100-tooth wheel driving one of 85 teeth, which latter revolves at 16 revolutions per minute. What is the size of the first driven wheel?

Drivers 16 and 100.
Driven 85.

```
  100
   16
 1600
   17
11200
1600
16)27200(1700
  16
  112
  112
```

```
85)1700(20
  1700
```

Ans. 20 teeth.

Worm Wheels.—These are used in order to rapidly diminish speed, as drivers only, and usually are single threaded, and are equal to one tooth as a multiplier of speed. For example, a worm wheel revolves 700 times a minute, and drives a 140-tooth wheel. What is the speed of the latter?

$700 \times 1 \div 140 =$ *Ans.* 5 times per minute.

Had the worm wheel been double threaded it would have taken two teeth at one revolution, and the result

would have been 10, obtained thus:—700 × 2 ÷ 140 = *Ans.* 10.

A Mangle Wheel is used in order to reverse its own direction of motion, and as a driven wheel only. Its speed is calculated as if it were an ordinary wheel, excepting that its size is taken as one tooth less than it is actually, in consequence of the tooth at each end being used only once in a double revolution, while all the others are used twice.

A 10-pinion revolving 360 times a minute drives a mangle wheel of 181 teeth or pegs. How many times will the mangle wheel revolve in a minute? 360 × 10 ÷ 180 = 20 revolutions (equalling 10 in each direction).

To change the Speed of a Driven Pulley, Shaft, or Wheel.

Rule E.—*Increase the size of the driver or decrease the size of the driven pulley in exact proportion to the increase of speed required.*

Case I.—To increase the speed by increasing size of driver.

A loom is run at 180 picks per minute, and it is desired to run it at 200. The driving pulley on the line shaft of shed is $13\frac{1}{2}$ inches in diameter. What size is required? Multiply $13\frac{1}{2}$ × 200, and divide by 180.

Ans. 15 inches diameter.

Case II.—To increase the speed by decreasing size of driven wheel.

The tappets of looms are set for a six-shaft cloth, and it is desired to weave a five-shaft satin. Thus the speed of the shaft carrying the tappets has to be increased in

the proportion of five to six. The driven wheel on the tappet shaft is a 60.

Multiply $60 \times 5 \div 6 = 50$ wheel required.

Circumferential Velocity.—To ascertain the circumferential velocity of a wheel, driver, or cylinder.

Rule F.—*Multiply the circumference in feet by the number of revolutions per minute.*

Example.—A beaming frame drum is 6 feet in circumference, and makes 48 revolutions per minute. What is the circumferential velocity?

$$6 \times 48 = 288$$

Ans. 288.

To Calculate Power of Leather Straps.—To calculate the power of single leather belts, the following **Rule G.** may be used:—

Let H P = actual horse-power.
W = width of belt.
F = driving force.
T = working tension from 70 to 150 lbs.
V = velocity of belt in feet per minute.

$$\text{Then} = \frac{W \times T}{2} \qquad H\,P = \frac{V \times F}{33000} \qquad W = \frac{33000 \times H\,P}{F \times V}$$

Example.—A 10-inch belt running 2500 feet per minute, what horse-power will it transmit? Assuming ing the working tension to be 100 lbs.—

$$F = \frac{10 \times 100}{2} = 500 \qquad H\,P = \frac{2500 \times 500}{33000} = 38 \text{ horse-power.}$$

Horse-power of Ropes.—The following table, compiled by Mr. A. G. Brown, and published in the catalogue of Messrs. J. Musgrave & Sons, Limited, Bolton, gives the power that good cotton driving ropes will transmit:—

Table VII.—Horse-power of Cotton Driving Ropes.

(A. G. BROWN.)

Velocity in Feet per Minute.	Diameter of Ropes in Inches.								
	½	⅝	¾	⅞	1	1¼	1½	1¾	2
600	0.84	1.30	1.91	2.60	3.43	5.30	7.69	10.40	13.52
700	0.98	1.52	2.23	3.03	4.00	6.18	8.96	12.12	15.75
800	1.12	1.73	2.54	3.45	4.56	7.05	10.22	13.82	17.96
900	1.26	1.94	2.86	3.88	5.12	7.92	11.48	15.52	20.17
1000	1.39	2.15	3.16	4.30	5.67	8.76	12.72	17.18	22.34
1100	1.53	2.35	3.47	4.71	6.22	9.61	13.94	18.83	24.48
1200	1.66	2.56	3.77	5.12	6.76	10.44	15.15	20.47	26.61
1300	1.79	2.76	4.07	5.53	7.29	11.27	16.35	22.10	28.73
1400	1.92	2.96	4.36	5.93	7.83	12.10	17.55	23.72	30.83
1500	2.05	3.16	4.65	6.32	8.34	12.89	18.70	25.27	32.86
1600	2.18	3.36	4.94	6.74	8.86	13.70	19.88	26.86	34.92
1700	2.30	3.55	5.22	7.10	9.37	14.48	21.01	28.39	36.90
1800	2.42	3.74	5.50	7.47	9.86	15.25	22.12	29.89	38.85
1900	2.54	3.92	5.76	7.83	10.34	15.97	23.18	31.32	40.71
2000	2.66	4.10	6.03	8.20	10.82	16.72	24.26	32.79	42.62
2100	2.77	4.27	6.29	8.54	11.28	17.43	25.29	34.17	44.42
2200	2.88	4.45	6.55	8.90	11.75	18.16	26.35	35.60	46.29
2300	2.99	4.62	6.80	9.24	12.19	18.84	27.34	36.94	48.03
2400	3.10	4.78	7.04	9.56	12.62	19.51	28.31	38.26	49.73
2500	3.20	4.94	7.28	9.89	13.05	20.17	29.26	39.55	51.41
2600	3.30	5.09	7.50	10.18	13.44	20.77	30.14	40.73	52.96
2700	3.39	5.24	7.71	10.48	13.83	21.37	31.00	41.90	54.47
2800	3.48	5.38	7.92	10.75	14.20	21.94	31.84	43.02	55.93
2900	3.57	5.51	8.12	11.03	14.56	22.50	32.64	44.11	57.35
3000	3.66	5.65	8.31	11.30	14.91	23.04	33.44	45.18	58.74
3100	3.74	5.78	8.50	11.56	15.25	23.57	34.20	46.22	60.08
3200	3.83	5.90	8.69	11.81	15.59	24.09	34.95	47.23	61.40
3300	3.90	6.01	8.85	12.02	15.87	24.53	35.59	48.10	62.53
3400	3.96	6.12	9.01	12.23	16.15	24.96	36.21	48.94	63.62
3500	4.03	6.22	9.15	12.44	16.42	25.37	36.81	49.75	64.67
3600	4.09	6.31	9.29	12.63	16.67	25.76	37.38	50.51	65.66
3700	4.15	6.41	9.43	12.81	16.91	26.13	37.92	51.24	66.62
3800	4.20	6.48	9.53	12.95	17.10	26.43	38.35	51.82	67.36
3900	4.25	6.56	9.65	13.12	17.32	26.76	38.83	52.48	68.22
4000	4.29	6.62	9.75	13.24	17.48	27.01	39.20	52.97	68.86
4100	4.33	6.68	9.83	13.36	17.63	27.25	39.53	53.42	69.44
4200	4.36	6.73	9.91	13.46	17.77	27.46	39.84	53.84	69.99
4300	4.39	6.78	9.98	13.55	17.89	27.65	40.11	54.21	70.47
4400	4.41	6.80	10.01	13.60	17.95	27.75	40.26	54.40	70.72
4500	4.42	6.82	10.04	13.64	18.00	27.82	40.36	54.55	70.91
4600	4.43	6.83	10.06	13.66	18.03	27.87	40.44	54.64	71.04
4700	4.43	6.84	10.07	13.67	18.05	27.90	40.48	54.70	71.10
4800	4.43	6.84	10.07	13.67	18.05	27.90	40.48	54.70	71.10
4900	4.43	6.83	10.06	13.66	18.03	27.87	40.44	54.64	71.04
5000	4.41	6.80	10.01	13.60	17.95	27.74	40.25	54.40	70.70
5500	4.24	6.54	9.63	13.08	17.27	26.69	38.73	52.33	68.04
6000	3.89	6.00	8.83	12.00	15.84	24.48	35.52	48.00	62.40
6500	3.38	5.22	7.68	10.04	13.78	21.30	30.90	41.76	54.29

MENSURATION.

SOME of the simpler rules of this science find a frequent use in the manufacturer's calculations as regards the machinery, and these are given below. Many readers will no doubt be fully acquainted with them, but there are others to whom the information may be acceptable.

To find the Area of a Circular Space.

Rule A.—*Square the diameter* (*shown by the line* A, B, Fig. 1) *and multiply by* .7854, *or multiply the radius by half the circumference.*

Example.—The diameter of an engine piston is 18 inches. What is its area?

Square $18 = 18 \times 18 = 324$

$324 \times .7854 =$

$$\begin{array}{r} .7854 \\ \underline{324} \\ 31416 \\ 15708 \\ \underline{23562} \\ 254.4696 \end{array}$$

Ans. 254.46 square inches.

To find the Circumference (A, C, F, B, D, Fig. 3) of a Circle.

Rule B.—*Multiply the diameter by* 3.1416.

Example.—A tape cylinder is 7 feet diameter. What is its circumference?

$$3.1416 \times 7 = 22 \text{ feet nearly.}$$

N.B.—3.1416 is nearly $3\frac{1}{7}$, and for rough work this is near enough for a multiplier.

Radius (A, D, Fig 1) is half the diameter.

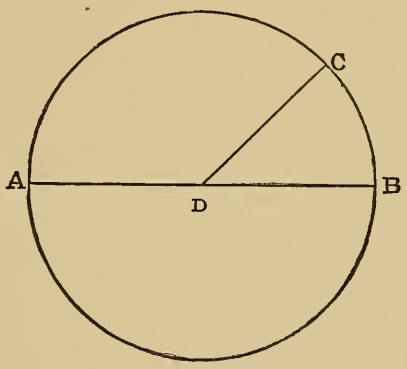


Fig. 1.

Angle.—An angle is the corner formed by the meeting of two straight lines, other than in a straight line, thus—

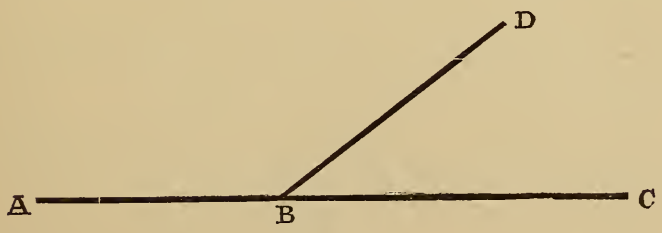


Fig. 2.

The angle D, B, C (Fig. 2) is an acute angle, while A, B, D (Fig. 2) is an obtuse one.

All angles are measured by the number of degrees

which they contain. Every circle is divided into 360 equal parts, each of which is called a degree. If two diameters of a circle cross each other at right angles, as A, B and C, D in Fig. 3, they make four angles of 90°. Every angle which contains 90° is a right angle; half of a right angle (B, O, F) is an angle of 45°; and a third

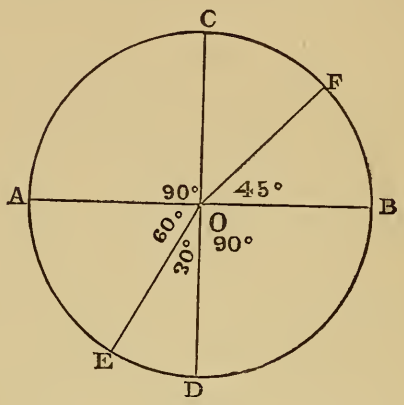


Fig. 3.

of one (E, O, D) is an angle of 30°. The right angle contains 90°, and is so called because it is the standard angle by which we measure other angles, just as the straight line is often called a right line because it is the standard by which we measure and test all other lines.

To find Contents of a Cubical Block.

Rule C.—*Multiply length, width, and depth together.*

To find Contents of a Cylinder.

Rule D.—*Find the area of one end, and multiply by the length of the cylinder.*

WINDING, WARPING, AND BEAMING CALCULATIONS.

Winding.—The process here referred to[1] is winding from cops to bobbins, the latter intended for the beaming frame or warping mill.

Specification of Winding per 1000 Looms, the latter on ordinary plain goods, about 32's twist counts.

No. of winding spindles	1200
„ frames	4
„ spindles each side of frame	150
„ winders per side, 5; in all	40
„ winders per beaming frame	4
Size pulley on frame end	12
„ tin roller	8
Length spindle	16 in.
Diameter wharve on front row of spindles	$1\frac{1}{4}$ „
„ „ back „ „	$1\frac{1}{2}$ „
Length of lift or traverse	$4\frac{1}{2}$ „
Size of bobbin, diameter of head	4 „
„ „ „ barrel	$1\frac{1}{2}$ „

To find Speed of Spindle.—Use Rule A. given on page 59.

Example.—Driving shaft speed . . 168

Drum on driving shaft	11	in.
Pulley on frame end	12	„
Size tin roller	10	„
Diameter spindle wharve	$1\frac{1}{4}$	„

$168 \times 11 \times 10 \div 12 \times 1\frac{1}{4} = 1232$ per minute.

---

[1] For a full description of this and all other preparatory processes of weaving, refer to the author's book on "Cotton Manufacturing."

To find Percentage of Waste.

Rule A.—*Add two cyphers to weight of waste, and divide by weight of twist from which it is made.*

Example.—A winder in a week winds 580 lbs. of twist, and makes 8 lbs. of waste.

580)800(1.379 per cent.
580
2200
1740
4600
4060
5400

Particulars required before Beaming.[1] To get Length for Beaming.

Rule B.—*Multiply warp length* (explained on page 16) *by number of pieces required.*

Example.—An order is given for 180 pieces of 75 yard cloth made from 80 yards of warp. How many yards of warp are required?

$$80 \times 180 = 14400 \text{ yards.}$$

Wraps.—The length of a warp is usually expressed in wraps, of which there are various lengths. The commonest are—

3000 yds.	to the	wrap	divided into	100	teeth of	30	yds. to the	tooth.
3500	,,	,,	,,	100	,,	35	,,	,,
3564	,,	,,	,,	132	,,	27	,,	,,
3600	,,	,,	,,	100	,,	36	,,	,,

[1] In some districts, notably Blackburn, Darwen, and surroundings, this process is called warping, which term is erroneous. Warping, strictly speaking, refers only to the old style of circular mill, with heck, for making ball and chain warps.

If the beaming length of the 180 pieces just mentioned had to be expressed in wraps of the first size, the calculation would be—

$$\begin{array}{r} 3000)14400(4 \text{ wraps} \\ 12000 \\ \hline 30)2400(80 \text{ teeth} \\ 2400 \\ \hline \end{array}$$

Ans. 4 wraps 80 teeth.

Number of pieces that can be made in a set.

Rule C.—*Multiply the number of wraps in a set by the length of a wrap, and divide by the length of warp per piece.*

Example.—The set of beams consists generally of four or five wraps on each beam. How many 100 yard pieces can be made out of a 5 wrap (3500 yards) set?

Allowing 5 per cent. to the 100 yards for contraction, we should proceed—

$$5 \times 3500 \div 105 = 17500 \div 105 = 166\tfrac{2}{3}.$$

Ans. $166\frac{2}{3}$ pieces.

Ends in a Set.—The number of ends in a set are equal to those in the piece of cloth desired to be made, and the number is ascertained as shown on page 14. The number of ends is generally too large to be held on one warper's beam, and is divided among several.

If 2100 ends are required they would be made on five beams of 420 each, probably.

If 3100 were required they would be obtained, perhaps, by six 444's and one 436.

No definite rule can be given for this, or, in fact, is

necessary, as almost each mill is circumstanced differently.

Weight of a Beam or Set of Beams.—To ascertain by calculation.

Rule D.—*Multiply the total ends by the length in yards, and divide by* 840 *and the counts.*

Example.—A set of beams consists of five, each 420 ends and 4 wraps (3000 yards long). Counts 30's. What is the weight of the set?

$5 \times 420 = 2100$ ends. $4 \times 3000 = 12000$ yards.

$$\begin{array}{r} 12000 \\ 2100 \\ \hline 1200000 \\ 24000 \\ \hline 840)25200000(30000 \\ 2520 \\ \hline 30)30000 \end{array}$$

Ans. 1000 lbs. weight.

Counts of Beams.—To find the counts of a beam or set of beams by calculation.

Rule E.—*Divide the length by* 840 *and the weight.*

The object here is obviously to find the number of hanks by using 840 as a divisor, and then find the number of hanks in the pound by dividing by the weight. The number of hanks per pound is equivalent to counts.

Example.—A beam weighs 210 lbs., and contains 500 ends. It is 15,000 yards long. What are the counts? 15000 multiplied by 500 and divided by 840 and 210 gives 42.51.

Ans. 42.51's counts.

Warping Calculations. Ball or **Chain Warping,** otherwise circular-mill warping. This process, almost indispensable at one time for all varieties of goods, is now largely superseded by the beaming frame for plain and grey goods and the section-warping for coloured goods, but is still used to a considerable extent in the coloured weaving trade and in many of the outside manufacturing districts.

The mill is usually from 10 to 18 yards in circumference, with staves set a foot apart all round; for sample work, small mills of 5 yards in circumference are used, and in Scotland 4 or 5 ells of 45 inches and 10 feet high. The bank or creel is sometimes constructed to hold as many as 500 bobbins, although it is more usual to work a much less number.

To Determine the requisite Number of Revolutions to make a Warp.

Rule F.—*Divide the length of warp required by the circumference of the mill.*

Example.—For a 360-yard warp with an 18-yard mill, 20 turns would be required before reversing. For a warp of 100 ells on a 4-ell mill, 25 revolutions would be required.

Another example.—How many revolutions of the mill will be made in one layer of a sample warp, 2000 ends, 20 yards, allow 24 inches at each end for gaiting, a 15-yard mill being used?

The total length of warp is 21 yards 1 foot, as 4 feet are allowed altogether for gaiting. 15 yards divided into 21⅓ yards gives one complete round and 6⅓ yards (equal-

ling 19 feet) over. Therefore the first layer would occupy one round and 19 staves towards another round.

Layers.—Generally, in fact almost always, the number of ends in the warp is several times as many as there are bobbins in the creel, and the mill has to be turned backwards and forwards till the required number of layers have been obtained.

The number of ends in the warp determines the number of layers to be warped.

Rule G.—Divide the number of ends in the warp by the number of bobbins in use in the creel.

Should there be 200 bobbins in the creel, and 2400 be required to form a warp, then $2400 \div 200 = 12$ layers are required.

These are usually expressed in bouts, millgangs, or returns, which mean once down and once up. Therefore for 2400 ends six bouts would be required.

Thus, six bouts of an 18-yard mill, with 200 bobbins in the creel and 20 turns of the mill before reversing, would give a warp of 360 yards length and 2400 ends. The number of bobbins in the creel should always divide into the number of ends in the warp without remainder, otherwise it necessitates breaking out at the last layer.

In Scotland 20 splits equal 1 porter, and the number of ends in a warp are expressed frequently in porters and splits—thus, 60 porters 10 splits.

The number of bobbins in the bank of a mill equals therefore the number of splits (two ends) in a complete bout. To find the number of bouts it is usual to use—

Rule H.—*To divide the number of splits in the web by the bobbins in the bank.*

Example.—With 110 bobbins in bank, and 60 porters 10 splits in the web. How many bouts of the mill are required?

$$\begin{array}{r} 60 \\ 20 \\ \hline 1200 \\ 10 \\ \hline 110)1210 \\ 11 \end{array}$$

Ans. 11 layers.

Weight of Warp.—To find the weight or counts of a ball warp use the rules given on page *72* for a beam warp.

Pinion.—The pinion at the upper part of the mill requires changing smaller when very long warps are made so as to get the layers closer together, and thus more length on the mill. The sizes are in exact proportion to the distances from centre to centre of each layer, but usually do not require such exact adjustments to necessitate any examples being given here.

Beaming. Specification for 1000 Looms, plain goods, about 32's twist.

No. of beaming frames . . .	10
Capacity	500 ends.
Creel either V or bed creel.	
Measuring roller circumference . .	18 in.
Cylinder diameter	20 ,,
Beam, length between flanges . .	54 ,,
,, diameter of flange . . .	22 ,,
,, ,, timber . . .	5 ,,

Measuring Motion.—For the purpose of measuring the length of yarn on the beam, each beaming frame is

supplied with a roller half a yard in circumference, round which the yarn passes; on the end of this roller is a worm driving a worm wheel of 54 teeth, which we will call B; on the stud carrying B is a second worm driving a worm wheel C of 132 teeth. The worm only takes one tooth at each revolution, therefore a complete revolution of the first worm wheel represents a length of 27 yards having passed the measuring roller; this is equal to one tooth only on the second wheel B; therefore, a complete revolution of the latter means 3564 yards—technically called a wrap—$\frac{1}{2} \times \frac{54 \times 132}{1 \times 1} = 3564$. If a warp contains 4 wraps and 7 teeth, it is 14,445 yards long = 4×3564 added to 7×27.

Table VIII.—Showing the Weight of Beams of Various Ends, Counts, and Length of Wraps.

No. of Ends.	Five Wraps of 3000 yards each = 15,000 yards.					Four Wraps of 3564 yards each = 14,256 yards.				
	24's T.	30's T.	34's T.	40's T.	50's T.	24's T.	30's T.	34's T.	40's T.	50's T.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
400	298	238	210	179	143	283	226	200	170	136
410	305	244	215	183	146	290	232	205	174	139
420	313	250	221	188	150	297	238	210	178	143
430	320	256	226	192	154	304	243	215	182	146
440	327	262	231	197	157	311	249	220	187	149
450	335	268	236	201	161	318	255	225	191	153
460	342	274	242	205	164	325	260	230	195	156
470	349	280	247	210	168	332	266	235	199	160
480	357	286	252	214	171	339	272	240	204	163
490	364	292	257	219	175	346	277	245	208	166
500	372	298	263	223	178	353	283	250	212	170

Notes.—No fractions of pounds are given. Fractions of $\frac{1}{2}$ lb. or more are taken as a full pound.

The weight of any other counts or number of ends can easily be obtained by proportion.

To find the weight of 5 wraps of 3500 yards add $\frac{1}{6}$ to weight of 3000 yards; or to find the weight of 5 wraps of 3600 yards add $\frac{1}{5}$ to weight of 3000 yards.

SLASHING OR TAPING CALCULATIONS.

Specification for 1000 Looms, plain sorts, 32's in counts.

No. of frames if weaving about 12 to 14 pick cloth, 4
" " " 16 to 20 " 3
" " " 24 to 30 " 2

Cylinders 7 feet and 4 feet diameter. Width to suit looms.

Marking Motion Calculations.—To enable the weaver to finish the piece when a required length has been woven, the warp is marked at the sizing frame at a certain length. This is generally done for plain goods by means of a measuring roller 14.4 inches in circumference, round which the twist passes. On the end of this is a tin roller wheel driving a change wheel or stud wheel. By means of a worm on the same stud the motion is transferred to a bell wheel of 45 teeth, which drives a marking cam so arranged as to gradually lift and suddenly drop a hammer, which smites the warp against a block soaked in some colouring matter.

To get the Wheels for a certain length, *e.g.*, **the Stud Wheel.**

Rule A.—*Multiply the length of mark desired in inches by tin roller wheel, and divide by the bell wheel and the circumference of tin roller.*

Example.—Suppose we desire to mark every $30\frac{1}{2}$ yards, and have on a tin roller wheel of 36.

$30\frac{1}{2}$ yards = 1098 inches.

$1098 \times 36 \div 45$ and 14.4

$$\begin{array}{r} 1098 \\ \underline{\times\ 36} \\ 6588 \\ \underline{3294} \\ 45)39528(878.4 \\ \underline{360} \\ 352 \\ \underline{315} \\ 378 \\ \underline{360} \\ 180 \end{array}$$

$$\begin{array}{r} 14.4)878.4(61 \text{ teeth in stud wheel} \\ \underline{864} \\ 144 \\ \underline{144} \\ \ldots \end{array}$$

Note.—45×14.4 equals 648, which is generally used as divisor.

To get the Tin Roller Wheel.

Rule B.—*Multiply the circumference of measuring roller by bell wheel and by stud wheel, dividing by the length of mark required.*

Example.—A mark of 45 yards 32 inches is required with a 51 stud wheel. What tin roller wheel must be used?

$14.4 \times 45 = 648 \times 51 = 33048$

45 yards 32 inches = 1652)33048(20

$$\begin{array}{r} \underline{3304} \\ 8 \end{array}$$

Ans. 20 tin roller wheel. This is not exactly right, but 20 is the nearest wheel that can be got.

A very simple and yet reliable rule has been sent to me by a correspondent. It is

To get Wheels for any Length of Cut.

Rule C.—*Divide the length in inches desired by* 648 (14.4×45). *The quotient in the form of a vulgar fraction shows the wheels required. The numerator will represent the stud wheel, and the denominator will indicate the tin roller wheel.*

Example.—Take the example from the previous page, for the $30\frac{1}{2}$ yard cut. $30\frac{1}{2}$ yards = 1098 inches; 1098 divided by $648 = \frac{61}{36}$, then the stud wheel is 61 and the tin roller wheel 36.

To find what length the wheels will give.

Rule D.—*Multiply* 648 *by the stud wheel, and divide by the tin roller wheel.*

Example.—What length will 44 tin roller and 100 stud wheel give?

$100 \times 648 = 64800$

$$
\begin{array}{r|l}
44 & 64800 \\
\hline
 & 1472\frac{3}{4} \\
 & 44 \\
\hline
 & 208 \\
 & 176 \\
\hline
 & 320 \\
 & 308 \\
\hline
 & 120 \\
 & 88 \\
\hline
 & 32 \\
\hline
 & 44
\end{array}
$$

$$
\begin{array}{r|l}
36 & 1472\frac{3}{4} \text{ inches} \\
\hline
 & 40 \text{ yards } 32\frac{3}{4} \text{ inches}
\end{array}
$$

Ans. 40 yards $32\frac{3}{4}$ inches.

Dhootie Marker.—In marking dhooties, in addition to the smit for the end of the piece, additional smits have

to be made where the heading for each scarf has to be inserted. Usually this is done by having an additional train of wheels and an extra marker, called a dhootie-marker, to strike 3, 4, or 6, &c., times for the cut-marker's once. In Fig. 4 a special arrangement is shown. The usual wheels are shown at *h*, the worm *i*, the bell wheel *k*, the bell shaft cut-mark hammer *m*. The other

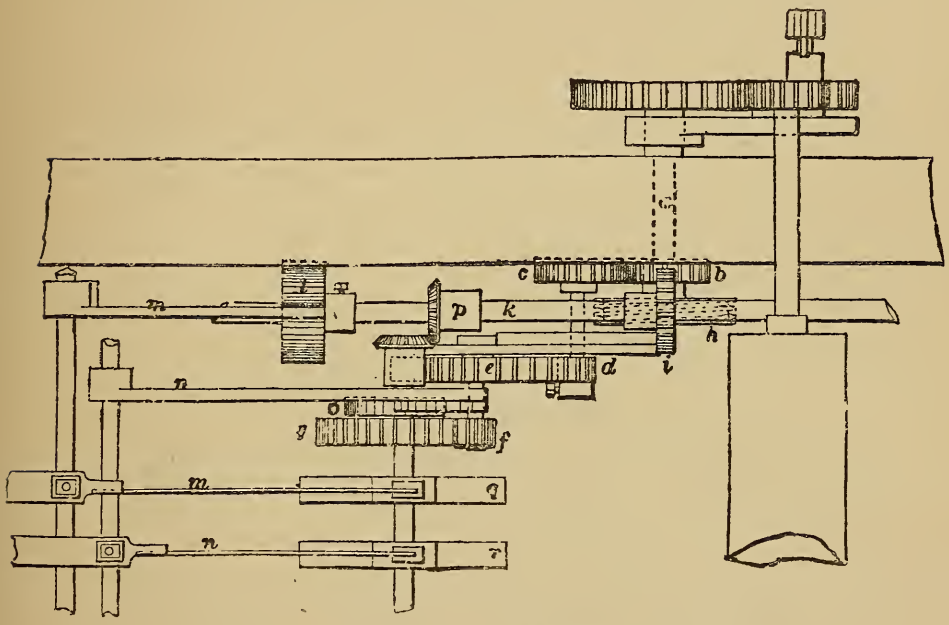


Fig. 4.—Dhootie-Marker.

wheels and the marker *n* refer to the dhootie-mark; *b* is fixed to the stud and drives *c* with *d*, a pinion on another stud; the wheels *e*, *f*, and *g* complete the train, and on the same shaft as *g* a cam *o* operates the dhootie-marker. This is arranged to strike any number of times for once of the cut-marker, regulated by the number of teeth in the change wheel *f*, 10 teeth in which give one mark

to a cut mark, 30 give three marks to a cut, 100 ten marks to a cut, and so on by somewhat similar systems for higher numbers. This marker is made by Messrs. Howard & Bullough.

To find the actual Percentage of Size put on the Yarn.

Rule E.—*To find the size actually put on the yarn, subtract the weight of the unsized yarn less waste from the sized yarn—e.g.,*

1639 actual sized weight.
1300 weight of yarn before sizing less waste.
339 = weight of size.

1300)33900(26.07 per cent. actual.
2600
7900
7800
100

Example—Counts after Sizing.—Apply Rule E., page 72. 2280 ends 4 wraps of 3564 yards each weigh 1639 lbs.

$$\frac{14256 \times 2280}{1639 \times 840} = 23.61\text{'s counts.}$$

The author, in his book on "Cotton Manufacturing," describes the process of sizing, also sizing materials, and machinery.

LOOM CALCULATIONS.

RITHMETICAL problems, as far as regards weaving machinery, bear reference chiefly to speeds of different parts of the machine. These are necessary ones, but not very intricate, and the rules common to all speed calculations previously given can be here applied.

The take-up motion is a special piece of apparatus, and requires careful consideration, as do also one or two calculations referring to fancy work.

To get the Speed of the Loom from the Engine.

Rule A.—*Multiply the speed of the engine by the dimensions of driving wheels, and divide by the dimensions of the driven wheels.*

Example.—Engine speed, 46 revolutions per minute; spur driving wheel, 105 teeth; pinion, 53 teeth; second motion driving wheel, 52 teeth; line shaft in shed, 49; drum on line shaft, 15 inches diameter; loom pulley, 8 inches.

$$46 \times 105 \times 52 \times 15 \div 53 \times 49 \times 8.$$

```
   46
  105
  230
 460
 4830
   52
 9660
24150
251160
   15
1255800
251160
53)3767400(71083
  371
   57
   53
    440
    424
     160
```

```
49)71083(1450
  49
  220
  196
   248
   245
    33

8)1450
  181 1
```

Ans. 181 revolutions of crank shaft or picks per minute.

This is the calculated speed, but about 4 per cent. may be allowed for *slip*, which leaves a result of about 174 picks per minute.

Changing Speed of Loom.—An example is given on page 63.

To obtain Speed of the Bottom Shaft (in the plain loom called the tappet shaft) **from the Crank Shaft.**

Apply Rule A., given on page 59.

[1] If all the fractions had been taken into account the result would have been slightly greater. In this and some other connections where it is not of importance to express the result in infinitesimal quantities, the fractional remainders are left out for convenience in calculation.

Example.—A loom crank shaft revolves 180 times in a minute. It carries a 41, driving an 82 on the bottom shaft. What is the speed of the latter?

$$180 \times 41 \div 82 = 90 \text{ revolutions per minute.}$$

To obtain the Number of Revolutions of a Crank Shaft for One Revolution of a Twill Shaft, Tappet Shaft, or Tappet Motion.

This corresponds with the number of picks per minute that the motion is adapted for.

Examples.

Case I.—When the twill shaft is under the loom and parallel to the bottom shaft—

e.g.,	Wheel on end of crank shaft .	40
,,	,, of bottom shaft .	80
,,	bottom shaft (driver) .	24
,,	twill shaft . . .	36

How many revolutions does the crank shaft make for the twill shaft one?

Apply Rule B., on page 61.

$$1 \times 36 \times 80 \div 24 \times 40 = 2880 \div 960 = 3.$$

The motion is then for a three-leaf twill.

Case II.—For a woodcroft tappet.

The crank shaft carries a 12; the tappet wheel is 108. How many picks are there to the round?

$$1 \text{ revolution of tappet} \times 108 \div 12 = 9 \text{ picks to the round.}$$

The same rule applies to side tappets without intermediate wheels, the carrier of course not entering into the calculations.

Case III.—For side tappets with an intermediate pair of wheels.

In this arrangement the crank shaft carries a driver gearing with the first of the intermediate wheels on a stud. On the same stud is the second intermediate wheel driving the wheel on the tappets.

Suppose the train of wheels is 20 driving 50, 18 driving 72, the 50 and 18 being the intermediate wheels on the stud. How many revolutions of the first driver (the crank shaft) are made for the tappet one?

Apply Rule B., on page 61.

$$1 \times 72 \times 50 \div 20 \times 18.$$

$$\begin{array}{r} 72 \\ 50 \\ \hline 20)3600 \\ 18)180 \\ \hline 10 \end{array}$$

Ans. 10.

Case IV.—A tappet motion, such as Smalley's sateen motion.

Example.—Crank shaft wheel 41, driving 82 on bottom shaft. Bottom shaft carrying 36 twist gear, driving 36 on upright shaft. 12 at top of upright shaft, driving 60 on tappets. How many revolutions of crank shaft for tappet shaft one?

Applying the Rule B., on page 61.

$$1 \times 60 \times 36 \times 82 \div 12 \times 36 \times 41 = 10 \text{ picks to the round.}$$

To find the Wheel or Wheels required to give the required number of Picks to the Round.

Use Rule C., on page 61.

Examples.

Case I.—Where the twill shaft is under the loom parallel to the bottom shaft. Suppose the crank shaft to carry a 41, driving an 82 on the bottom shaft, and we require the bottom shaft to drive the twill shaft to give 5 picks to the round, or, in other words, to make 1 revolution for the crank shaft 5.

We require the size of two wheels, and shall have to estimate one. Say we have a 100 on the twill shaft, then we want the size of the driver on the tappet shaft.

Applying rule—

$$1 \times 100 \times 82 \div 41 \times 5 = 40 \text{ the wheel required.}$$

Then the two wheels required are in proportion of 40 to 100, or say 20 and 50.

Case II.—A woodcroft tappet. Picks to round required, 16; size of tappet wheel, 192. How many teeth on crank shaft wheel?

Applying rule, divide driven wheel by speed of driver—

$$\frac{192}{16} = \text{wheel required on crank shaft.}$$

Ans. 12 teeth.

Case III.—Side Tappets.—To find one of the drivers to give a required speed, use Rule C., on page 61. For a 14 pick to the round, with a 10 on crank shaft, 35 on stud, and 40 on tappets. Find the driver on the stud. Multiply the speed of the driven shaft 1 by the driven wheels 35 and 40, and divide by the speed of the driver 14 × driving wheel 10.

$$\frac{35 \times 1 \times 40}{14 \times 10} = \frac{1400}{140} = 10$$

The train will be—

10 driving 35
10 „ 40

If it be one of the driven wheels that is wanted, apply Rule D., on page 62.

Example.—13 picks to round. 13 picks to the round must be woven, the wheel on the crank shaft being 25; the stud drives 13, and the last wheel on the same shaft as the tappets is 65. Then, to get the size of intermediate driven wheel on the stud, multiply the speed of driver 13 by the drivers 25 and 13, and divide this by the driven 65.

$1 \times 13 \times 13 \times 25 \div 65 = 65$ the wheel required.

If both intermediate wheels have to be found.

Rule B.—*Find the speed that the driven and driving wheels give, and this is to the required speed, as the two required wheels are to one another.*

Example.—17 picks to the round are required. There is a 10 on the crank shaft and a 25 on the tappets. What have the two intermediate wheels to be? The speed of the crank shaft for the tappets 1 with the given wheels is $25 \div 10 = 2\frac{1}{2}$. Then as $2\frac{1}{2}$ is to 17, so the required wheels. 10 and 68 would do, or 15 and 102. Take the latter, the train would then be—

10 driving 102
15 „ 25

Case IV.—Tappet motion above loom driven from bottom shaft by an upright wheel.

Example.—7 picks to round required, or the crank

shaft to revolve 7 times for tappet once. Crank shaft wheel 40, driving 80 on bottom shaft, 36 on bottom shaft driving 36. 70 on tappets. What is the size of the intermediate wheel?

Applying the Rule C., on page 61 :—

$$70 \times 36 \times 80 \div 7 \times 36 \times 40. \quad \textit{Ans.}\ 20.$$

The train of middle wheels would then be—

40 driving 80
36 „ 36
20 „ 70

Leverage.—To find the distance moved through by one end of a lever.

Case I.—Levers of the first order, when the fulcrum or centre on which it moves is between the power and the work.

Rule C.—*The length of the weight arm multiplied by the distance through which the power arm is moved, and divided by the length of the power arm, gives the distance through which the end of the weight arm moves.*

Example.—A lever 10 inches long, working on a centre 4 inches from one end, is moved 1 inch at its longer end. How far does it move at its shorter end?

The weight arm 4 inches × 1 inch ÷ the power arm 6 inches = $\frac{2}{3}$ inches.

Case II.—Levers of the second order, *i.e.*, where the weight is between the fulcrum and the power.

The same rule applies.

Case III.—Where the power is between the weight and fulcrum.

The same rule applies.

Size of Shed.—The ordinary treadles of the plain loom are levers of the second or third order, and the calculation of the size of the shed from given dimensions of the tappets and treadles forms a good example in leverage. Suppose the stroke of the tappet, or the distance through which it moves the treadle bowl, between the outer and inner circle is $3\frac{1}{2}$ inches. The treadle, a lever of the second order, is 30 inches long, the treadle bowl being 25 inches from the treadle pin, and the healds connected 15 inches from the pin or fulcrum at a point which we will call N. Then the movement of the heald from its highest to its lowest level is equal to the distance moved through by the point N—*i.e.*, 2.1 inches—for if the bowl moves $3\frac{1}{2}$ inches, the point N moves (by the rule) $\frac{3\frac{1}{2} \times 15}{25} = 2.1$ inches. This gives the size of the shed at the healds.

Suppose the heald in question is 7 inches from the fell of the cloth, the shuttle passing through the shed 2 inches nearer to the cloth, then the size of the shed at the heald multiplied by 5 and divided by 7 gives its size at the point where the shuttle passes through, or $2.1 \times 5 \div 7 = 1.5$ inches.

Take-up Motion.—Among cotton looms the positive take-up motion is generally used. The cloth as woven is, by this arrangement, drawn on the cloth roller a certain distance at every pick, the amount of take-up being regulated by wheels. Fig. 5 shows a sketch of the arrangement. The construction is similar for almost all looms, but there are different gears and sizes of wheels used. In Harrison's gear the rack wheel of 50 teeth receives its motion from a pawl, worked by one of the slay swords.

On the same stud is the change wheel. This gears with the stud wheel, 100 teeth, firmly connected with the pinion of 12 teeth, driving the beam wheel 75. The beam or sand roller is 15 inches in circumference, and is covered with glued sand, perforated tin, or some rough substance, to hold the cloth firmly. The fabric is wound on the cloth roller below this by means of contact with the sand roller. The change wheel is varied to give

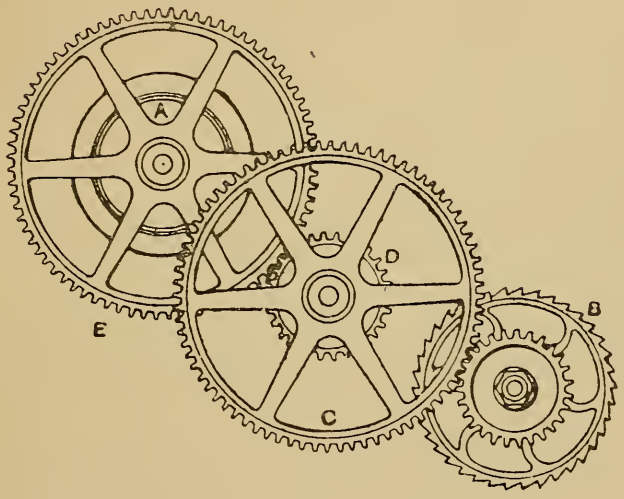


Fig. 5.

changes of picks in the cloth, a larger wheel giving fewer picks in the quarter inch. Each gear has a constant number associated with it, called a dividend.

To ascertain the Number of Picks in a Quarter Inch of cloth.

If the number of teeth in the change wheel be divided into this dividend, it *gives the picks in a quarter inch* of cloth. Imagining that a change wheel, having the

effect of only one tooth in a revolution, could be applied, then the dividend is the number of picks that the loom would run before the sand roller advanced a quarter of an inch. Suppose 528 dividend is taken, this represents a change wheel supposed to have one tooth. If a wheel of 66 teeth be put on, only $\frac{1}{66}$ as many picks to the quarter will be inserted—*i.e.*, $\frac{528}{66} = 8$ picks.

To ascertain the Number of Teeth in the wheel required for a number of picks per quarter inch of cloth.

Divide the number of picks per quarter inch into the dividend, and select the nearest wheel to the result obtained. Also see the following pages and Tables IX. and X.

Dividend.—The method of obtaining the dividend for any ordinary gear is—

Rule D.—*Multiply all the driven wheels together, and divide by the drivers and the circumference of the roller, thus—*

$$\frac{\text{Rack wheel} \times \text{carrier wheel} \times \text{beam wheel}}{\text{Pinion wheel} \times \text{number of } \frac{1}{4} \text{ inches in circumference of taking-up roller}}$$

afterwards adding $1\frac{1}{2}$ per cent. for shrinkage of the cloth after being released from the tension of the loom.

Thus Harrison's gear gives—

$50 \times 75 \times 100 \div 12 \times 60$	=	520.8	
Add $1\frac{1}{2}$ per cent.	=	7.8	
Dividend	.	528.6	usually taken as 528

The principal gears in use in Lancashire are:—

	Rack Wheel.	Stud and Carrier Wheel.	Pinion.	Beam Wheel.	Circumf. Take-up Roller.	Dividend.
J. Harrison & Sons, now J. Dugdale & Sons . .	50	100	12	75	15	528
Willan & Mills . . . . J. Dugdale & Sons . . . J. & R. Shorrock . . .	50	120	15	75	15	507
Butterworth & Dickinson	50	120	18	100	16	528
Pickles	24	89	15	90	15	...

To weave heavy pick cloth with, say, the first-named motion, the rack wheel might be increased to 60 from 50, and the dividend would then be 634.

Pickles' gear also has a swing pinion 24, and two change wheels. To find the change wheel required, multiply the change wheel on the rack stud by the picks per quarter inch, and divide by 9—

Equal to 4 teeth per pick for a 36 change wheel.
" 3 " " 27 "
" 2 " " 18 "

By using this motion both heavy and light pick cloth can be woven without a great variation in the wheels.

The dividend is not given for Pickles' motion; in fact the constant number is a multiple and not a dividend. There are two extra wheels in Pickles' motion on a swing between the stud wheels and rack wheels. One of these is a swing pinion, 24, and the other is a change wheel. There are thus two change wheels. The one on the rack stud is generally considered a standard one, and is either

18, 27, 36, or 45, each of which, it will be noticed, is a multiple of 9: a 36 is often used. The other change wheel on the swing stud is the one altered for picks, and supposing a 36 standard to be used, then the number of picks per quarter inch multiplied by 4 gives the change wheel required. If the standard were 27, then the number of picks multiplied by 3 gives the wheel required. If an 18 standard be used, then the number of picks multiplied by 2 gives the change wheel. The advantages of this motion are:—the possibility of obtaining the same fraction of a pick in difference by changing one tooth, whether in low pick or heavy pick cloths—in other words, each tooth having the same value; also a smaller range of change wheels, as a change of the standard wheel makes the same set of change wheels serve for heavy picked as well as for light picked cloths; also the possibility of changing to a $\frac{1}{4}$ pick in heavy goods, which is very difficult and unusual with the dividend system of gears.

Example.—Applying Rule D. to Pickles' motion, the drivers are 24 rack wheel, the variable change wheel, which we want to find, the 89 stud wheel, and the 90 beam wheel. The driven wheels are the standard wheel, the swing pinion 24, and the stud pinion 15.

$$\text{Then } \frac{24 \times 89 \times 90}{24 \times 15 \times 60}$$

	8.9
Add $1\frac{1}{2}$ per cent.	.1
	9.0

The calculation is not yet completed, as we have another change wheel—the standard. Suppose it is to

be a 36, and using 9 as a divisor, the result is $\frac{36}{9}$, or 4. If a 27 standard be used, $\frac{27}{9} = 3$. With an 18, $\frac{18}{9}$ is 2. The figure 4 obtained with the 36 is not a dividend but a multiplier if we desire to find what wheel is used for a certain number of picks per quarter, or divisor if the picks are required from the wheel.

Example.—Suppose a 36 standard is used, and the picks per quarter inch required are 20: 20 multiplied by 4 gives the number of teeth—80. If 17 picks are required per quarter inch, $17 \times 4 = 68$ wheel.

On the contrary, the figure 4 may be a divisor if the picks are required—*e.g.*, if a 48 wheel is used, what are the picks per quarter inch? $\frac{48}{4} = 12$; or with a 61 wheel, $\frac{61}{4} = 15\frac{1}{4}$ picks per quarter inch.

Table IX.—Pick Table, given in picks to the quarter inch.

Atherton's Gear.		Dickinson's Gear.				Harrison's Gear.			
Beam wheel . 80 Stud wheel . 120 Rack wheel . 60 Pinion wheel. 15 Emery bm. 15 in. Dividend . . 649		Beam wheel . 75 Stud wheel . 120 Rack wheel . 50 Pinion wheel. 15 Emery bm. 15 in. Dividend . . 507		Beam wheel . 75 Stud wheel . 120 Rack wheel . 80 Pinion wheel 15 Emery bm. 15 in. Dividend . . 811		Beam wheel . 75 Stud wheel . 100 Rack wheel . 50 Pinion wheel. 12 Emery bm. 15 in. Dividend . . 528		Beam wheel . 75 Stud wheel . 100 Rack wheel . 60 Pinion wheel. 12 Emery bm. 15 in. Dividend . . 634	
Change Wheel.	Picks.	Change Wheel.	Picks.	Change Wheel.	Picks.	Change Wheel.	Picks.	Change Wheel.	Picks.
15	43.26	15	33.8	15	54.06	15	35.2	15	42.266
16	40.56	16	31.69	16	50.68	16	33	16	39.625
17	38.17	17	29.82	17	47.7	17	31.06	17	37.294
18	36.05	18	28.17	18	45.05	18	29.33	18	35.222
19	35.21	19	26.68	19	42.689	19	27.79	19	33.368
20	32.45	20	25.35	20	40.55	20	26.4	20	31.7
21	30.904	21	24.143	21	38.623	21	25.143	21	30.19
22	29.5	22	23.045	22	36.863	22	24	22	28.818
23	28.217	23	22.043	23	35.26	23	22.956	23	27.565
24	27.041	24	21.125	24	33.791	24	22	24	26.417
25	25.96	25	20.28	25	32.44	25	21.12	25	25.36
26	24.961	26	19.5	26	31.192	26	20.308	26	24.385
27	24.037	27	18.778	27	30.037	27	19.556	27	23.481
28	23.178	28	18.107	28	28.964	28	18.857	28	22.643
29	22.379	29	17.483	29	27.965	29	18.207	29	21.862
30	21.633	30	16.9	30	27.033	30	17.6	30	21.133
31	20.935	31	16.355	31	26.161	31	17.032	31	20.452
32	20.281	32	15.884	32	25.343	32	16.5	32	19.813
33	19.666	33	15.364	33	24.575	33	16	33	19.212
34	19.088	34	14.912	34	23.852	34	15.53	34	18.647
35	18.542	35	14.486	35	23.171	35	15.086	35	18.114
36	18.027	36	14.083	36	22.527	36	14.667	36	17.611
37	17.54	37	13.703	37	21.918	37	14.27	37	17.135
38	17.078	38	13.342	38	21.342	38	13.895	38	16.684
39	16.641	39	13	39	20.794	39	13.538	39	16.256
40	16.225	40	12.675	40	20.275	40	13.2	40	15.85
41	15.829	41	12.366	41	19.78	41	12.878	41	15.463
42	15.452	42	12.071	42	19.309	42	12.571	42	15.095
43	15.093	43	11.791	43	18.86	43	12.279	43	14.744
44	14.75	44	11.523	44	18.431	44	12	44	14.409
45	14.442	45	11.267	45	18.022	45	11.733	45	14.089
46	14.108	46	11.022	46	17.63	46	11.478	46	13.783
47	13.808	47	10.787	47	17.225	47	11.234	47	13.489
48	13.52	48	10.563	48	16.895	48	11	48	13.208
49	13.244	49	10.347	49	16.51	49	10.776	49	12.939
50	12.98	50	10.14	50	16.22	50	10.56	50	12.68
51	12.725	51	9.941	51	15.9	51	10.353	51	12.431
52	12.48	52	9.75	52	15.59	52	10.154	52	12.192
53	12.24	53	9.566	53	15.30	53	9.962	53	11.962
54	12.02	54	9.389	54	15.01	54	9.778	54	11.741
55	11.8	55	9.218	55	14.74	55	9.6	55	11.527
56	11.59	56	9.054	56	14.48	56	9.429	56	11.321
57	11.37	57	8.895	57	14.22	57	9.263	57	11.123
58	11.29	58	8.741	58	13.98	58	9.103	58	10.931
59	11.00	59	8.593	59	13.74	59	8.95	59	10.746
60	10.81	60	8.45	60	13.51	60	8.8	60	10.567

At Table IX. a pick table is given showing the calculated picks for forty-six different wheels in five styles of gear. As will be imagined from a perusal of the list, the same wheels are not always used for the same pick at different mills, but the following scale gives a medium cloth, and is in use very largely. Poorer or better cloth can be made by using larger or smaller wheels respectively:—

Table X.

Picks to Quarter.	507 Dividend.	528 Dividend.	649 Dividend.
9	60	62	76
10	56	58	71
11	50	52	65
12	46	48	59
13	42	44	54
14	39	41	50
15	36	38	46
16	33	35	43
17	32	33	40
18	30	31	38
19	28	29	36
20	26	27	34
21	25	26	32
22	24	25	31
23	23	24	29
24	22	23	28

An Up-taking Motion, used in Scotland, consists of three wheels only (omitting wheels C and D in Fig. 5); the change pinion gearing directly with the beam wheel. Suppose the beam to be 13 inches in circumference, the beam wheel to be 140 teeth, and the rack wheel 120, the dividend for the number of picks *per inch* is got by

Rule E.—*Multiply the beam wheel and rack wheel together, and divide by the circumference of the roller in inches.*

$$140 \times 120 \div 13 = 1291 \text{ dividend.}$$

Thus for 43 picks to the inch a 30 wheel would be required, obtained by dividing 1291 by 43.

To many manufacturers it is no doubt preferable to have a dividend which, when divided by the shots on the glass, gives the necessary wheel; therefore we give

Rule F.—*Multiply the rack wheel by the beam wheel, and divide by the circumference of the up-taking roller expressed in two-hundredths of 37 inches.*

The dividend of the former example would be 120×140, and divided by 70.27, that being 13 inches expressed in $\frac{37}{200}$ of an inch—

$$120 \times 140 \div 70.27 = \underline{239}.$$

Suppose 17 shots on the glass were required—

$$239 \div 17 = \underline{14}.$$

Ans. 14 wheel required.

Jacquard Calculations.—In designing for Jacquard work many sizes of design paper are used—thus, 8×8, 12×9, 12×10, 10×8, signifying that the first-named number of squares across the paper occupy the same space as the latter number down the paper.

These are used so that a pattern may be in proportion on the paper to what it would be in the cloth, although in the latter it might have less picks than ends per inch.

For example, a square pattern woven 12 ends to the $\frac{1}{4}$ inch and 10 picks to the $\frac{1}{4}$ inch, if drawn on 12×10 design paper, would be as broad as long, if on 12×12 design paper would appear broader than long.

Apparently then the design paper to be used should be in proportion to the ends and picks per inch. If the cloth has to be 160 ends and 160 picks per inch, then the design paper must be as 160 to 160. For example, 8 × 8 would do.

If 132 ends and 110 picks per inch, the paper must be as 132 is to 110, *e.g.*, 12 × 10 paper.

Casting Out.—In lay-over patterns a number of ends are tied to one hook, and if the pattern contains as many ends as there are hooks, or some factor of the number, it is easy to calculate how many shall be tied. In a warp of 1600 ends in a 400 machine, and 400 ends in the pattern, four would be tied to each hook. With 100 ends in the pattern there would be 16 ends similar, which, however, would be divided between the four patterns representing the capacity of the machine, still giving four ends to a hook. In some cases, the number of hooks available for use cannot be divided by the number of ends in the pattern without remainder. This remainder cannot be used, and has to be cast out.

Rule G.—*After allowing for selvages, &c., divide the number of hooks available by the number of ends in the pattern, the remainder after division is the number to be cast out; the other hooks being all utilised.*

Example.—How many hooks would be cast out in a 408 machine, with 64 ends in the pattern, 8 hooks being used for selvages. The machine will weave six patterns and have 16 hooks to spare, which would be cast out—

64)400(6 groups
384
16

Ans. 16 hooks cast out.

One row of 8 would be cast in the middle and another at the end.

To find the ends for each Hook or Neckband.

Rule H.—*Divide the number of patterns in the width of the fabric by the number of groups of hooks available for them. This gives the number of ends to each hook, any surplus being added to one or more groups of hooks.*

Example.—Taking 1600 ends in a 400 machine, with 64 ends to the pattern, the 1600 ends, neglecting selvages, will give 25 complete patterns of 64 ends each in the width of the cloth; this will give four ends, otherwise four patterns, to each hook to five sets, and five patterns or five ends to a hook in the sixth set.

Casting out for coarser reed.

Rule J.—*Multiply the number of hooks in use for the finer reed by the coarser reed, and divide by the finer reed. The difference is the number to cast out.*

Example.—400 hooks are being used for 100 reed cloth. How many would have to remain at rest in weaving 80 reed cloth with the same Jacquard harness?

$$400 \times 80 \div 100 = 320$$
$$400 - 320 = 80 \text{ to cast out.}$$

Cumberboard.—The total number of holes per inch in the cumberboard must be equal at least to the number of warp ends per inch in the reed. If the cumberboard is finer than this, subtract the ends per inch in the reed from the ends per inch in the cumberboard, and the number to be left unused in each inch remains.

WAGE CALCULATIONS.

IN the cotton trade wages are now regulated chiefly by lists of prices drawn up and agreed upon by representatives of masters and operatives. This is a commendable system, not only because it obviates disputes, by having a standard to refer to in case of differences of opinion, but because each manufacturer and each district are placed on the same basis, and thus unfair competition is avoided. Earlier in the history of the cotton trade each master had his own list, and paid more or less than his competitors, as he was more or less favourably situated, or perhaps in some instances according to the rates to which he had been accustomed from the commencement of the factory system. The growth of trades' unions has compelled the adoption of fixed bases on which all makers must pay, forcing up the lowest prices, while at the same time increased competition has compelled those manufacturers who in times gone by have paid higher rates than their competitors to reduce their payments to the ordinary rates, and thus the standardised scales of payments have been adopted.

Almost the only disadvantage in standard lists is that when once fixed neither masters nor men seem inclined to make allowances for abnormal circumstances, such, for

example, as when an employer is engaged on producing cheap fabrics out of poor material, or where machinery is old or worn out. In these cases the work-people are obviously at a disadvantage. In other circumstances the employer is in the worse position where he has gone to great expense in providing the most modern machinery, or the most healthy workshop, or where he finds employment in a country neighbourhood for people who would otherwise be unemployed, and where he is at greater expense in carriage, cartage, lighting, and other expenses. In these cases the operative reaps the benefit if full rates are paid. The greatest unanimity of prices prevails in the weaving departments, and least in those branches where the fewest men are employed, such as taping or warehousing. In these departments each man has his own value based on his ability. The rates paid in each department will now be given, and where possible the districts in which each list is accepted will be noted.

Winding.

Mule Yarn, from Twist Cop to Warper's Bobbin.

Counts of Yarn.	Lbs. of Twist for 12*d.*	Counts of Yarn.	Lbs. of Twist for 12*d.*
18's. . .	65 lbs.	38's. . .	36 lbs.
20's. . .	62 ,,	40's. . .	33 ,,
22's. . .	57 ,,	46's. . .	30 ,,
24's. . .	52 ,,	50's. . .	28 ,,
26's. . .	49 ,,	60's. . .	24 ,,
28's. . .	46 ,,	70's. . .	21 ,,
30's. . .	44 ,,	80's. . .	18 ,,
32's. . .	42 ,,	90's. . .	16 ,,
34's. . .	41 ,,	100's. . .	15 ,,
36's. . .	40 ,,		

Above paid nett, and is an average of rates paid in Lancashire.

Ring frame or throstle frame yarn about 25 per cent. more for a shilling. No acknowledged list is paid in all the cotton districts, but the above is about the average.

In Burnley, $6\frac{1}{2}$d. per 20 lbs. of 32's twist is paid, and 5 per cent. added to the price for each two counts finer, and 5 per cent. deducted for each two counts coarser.

Below are the prices for winding allowed by the Preston list of 1860, and still current at some places in the town :—

Average of Prices Paid for Winding for 20 *lbs.*

Throstle.	Mule.	Throstle.	Throstle.
d.	d.	d.	d.
26 . . $3\frac{3}{8}$	...	50 . . 8	85 . . 14
28 . . $3\frac{1}{2}$	$5\frac{1}{2}$	55 . . $8\frac{1}{2}$	90 . . $15\frac{1}{4}$
30 . . $3\frac{5}{8}$	$5\frac{3}{4}$	60 . . 9	95 . . $16\frac{1}{2}$
32 . . $3\frac{3}{4}$	6	65 . . $9\frac{3}{4}$	100 . . 18
34	$6\frac{1}{4}$	70 . . $10\frac{1}{2}$	105 . . $20\frac{1}{2}$
36	$6\frac{1}{2}$	75 . . $11\frac{1}{2}$	110 . . 23
40	7	80 . . $12\frac{1}{2}$	120 . . 30
46	$7\frac{3}{4}$		

Coloured Yarn Winding.

When coloured yarn is used for warps, the yarn is dyed either in the warp or chain as a rule; but in goods where the amount of colour is small in proportion to the grey yarn (dhooties, for example, and also in other special goods), the yarn is dyed in the hank, and has to be wound to the warping bobbin. Rates vary very much for this; 1s. per bundle is often paid for 20's or 2/40's in

dhooty work. In other districts this rate gets as low as 8d. per bundle, but the average may be taken as 10d. A scale in proportion to this would be :—

12's	16's	20's	24's	28's	32's	36's	40's
8*d.*	9*d.*	10*d.*	11½*d.*	13*d.*	14½*d.*	16*d.*	17½*d.*

Pirn Winding.

Coloured wefts often require winding from hank to pirn, and this is more costly than winding the same yarn to the warper's bobbin. An average over the county of Lancashire would probably give :—

12's	16's	20's	24's	28's	32's	36's	40's
10*d.*	12*d.*	14*d.*	16½*d.*	19*d.*	21½*d.*	24*d.*	27*d.*

In each case the prices apply to a 10 lb. bundle.

Beaming.

(*Less* 10 *per cent.*)

Ends.	Price per wrap of 3564 yards.	Ends.	Price per wrap of 3564 yards.
300	3·75*d.*	410	4·93*d.*
310	3·85*d.*	420	5·04*d.*
320	3·96*d.*	440	5·28*d.*
330	4·07*d.*	460	5·52*d.*
340	4·15*d.*	480	5·76*d.*
350	4·29*d.*	500	6·00*d.*
360	4·40*d.*	520	6·26*d.*
370	4·5*d.*	550	6·66*d.*
380	4·6*d.*	580	7·05*d.*
390	4·71*d.*	610	7·45*d.*
400	4·82*d.*	640	7·85*d.*

No list has been officially adopted for this work, but the above may be taken as the average rate in North Lancashire.

Ball Warping.

Ball warping is paid either by the thousand hanks or by the 100 lbs., except in the case of small or difficult warps, which are made by time.

An average rate varies from 6d. to 8d. per 1000 hanks, and an allowance of 2d. per warp for all warps under 500 hanks. In some cases 1d. is allowed for each double lease, and from 6d. to 8d. per hour paid for making sample warps, or difficult coloured warps.

An average list of prices is for grey warps of not less than 800 hanks each :—

10's	.	7*d.* per 1000 hanks, or 7*d.* per 100 lbs.				
16's	.	$6\frac{3}{4}d.$	,,	,,	11*d.*	,,
24's	.	$6\frac{1}{2}d.$	,,	,,	$15\frac{1}{2}d.$	,,
32's	.	$6\frac{1}{4}d.$	,,	,,	20*d.*	,,
40's	.	6*d.*	,,	,,	24*d.*	,,

Example.—What is the price for warping 1400 ends, 840 yards, 2/60's ?

Weight of warp 1400 multiplied by 840 and divided by 840 gives 1400 hanks. At $6\frac{1}{4}$d. per 1000, the price for the warp is 8.75 pence.

Ans. $8\frac{3}{4}$d.

Slashing or Tape-Sizing.

The Blackburn list, framed some twenty-five years ago, is largely used where payment by list still obtains. Many mills now have the slashers or tapers, as they are variously called, paid at a fixed wage. The list is as under :—

Taking 2460 ends as a standard, deducting $\frac{3}{8}$d. for

every 50 ends below the standard, on 37½ yards per 100 cuts.

Taking 2460 ends as a standard, add ½d. for every 50 ends above the standard, on 37½ yards per 100 cuts.

Fractional parts of 50 ends given in favour of the workman.

Ends.	1460 to 1510	1560 to 1610	1660 to 1710	1760 to 1810	1860 to 1910	1960 to 2010	2060 to 2110	2160 to 2210
	d.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*
25 yds.	14.00	14.5	15.00	15.5	16.00	16.5	17.00	17.5
37½ ,,	21.00	21.75	22.5	23.25	24.00	24.75	25.5	26.25
46 ,,	25.76	26.68	27.6	28.52	29.44	30.36	31.28	32.2
60 ,,	33.6	34.8	36.00	37.2	38.4	39.6	40.8	42.00
100 ,,	56.00	58.00	60.00	62.00	64.00	66.00	68.00	70.00

Ends.	2260 to 2310	2360 to 2410	2460 to 2510	2560 to 2610	2660 to 2710	2760 to 2810	2860 to 2910	2960 to 3010
	d.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*
25 yds.	18.00	18.5	19.00	19.66	20.33	21.00	21.66	22.33
37½ ,,	27.00	27.75	28.5	29.5	30.5	31.5	32.5	33.5
46 ,,	33.12	34.04	34.96	36.186	37.413	38.64	39.86	41.093
60 ,,	43.2	44.4	45.6	47.2	48.8	50.4	52.00	53.6
100 ,,	72.00	74.00	76.00	78.66	81.33	84.00	86.66	89.33

Ends.	3060 to 3110	3160 to 3210	3260 to 3310	3360 to 3410	3460 to 3510	3660 to 3710	3860 to 3910
	d.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*
25 yds. . . .	23.00	23.66	24.33	25.00	25.66	27.00	28.33
37½ ,, . . .	34.5	35.5	36.5	37.5	38.5	40.5	42.5
46 ,, . . .	42.32	43.546	44.773	46.00	47.226	49.68	52.13
60 ,, . . .	55.2	56.8	58.4	60.00	61.6	64.8	68.00
100 ,, . . .	92.00	94.66	97.33	100.00	102.66	108.00	113.33

The preceding list is based upon medium counts of yarn. Extreme counts and extreme sorts to be allowed for as per agreement.

The list is paid less 10 per cent.

It is adopted in most manufacturing districts, excepting South Lancashire, where no deduction is made below 2500 ends.

Example.—Suppose the taper is engaged on 1970 ends for three days, and runs three sets each of 200—75 yards pieces, and for three days more on three sets of 1470 ends.

If 25 yards is adopted as the standard length of cut, he will have slashed $200 \times 75 \div 25 = 600$ cuts in a set—that is, 1800 cuts of 1970 ends, and 1800 cuts of 1470 ends, the rates of payment for which, according to the lists, are 16½d. per hundred and 14d. per hundred respectively.

1800 at 16½d. =	£1	4	9
,, at 14d. =	1	1	0
	£2	5	9
10 per cent. off	0	4	6
	£2	1	3

Looming with Lease.

16's to 22's . . .	2½d. per 1000 threads.
23's to 27's . . .	2⅜d. ,, ,,
28's to 55's . . .	2¼d. ,, ,,
56's to 80's . . .	2⅜d. ,, ,,
80's and upwards . .	2½d. ,, ,,
28's to 55's, without lease .	3¾d. ,, ,,

Three leases to have something allowed as per agreement. Double warps for worsted goods to have an allowance as per agreement.

Jobbing or labouring to be paid extra, at so much per hour. Yarns below 16's to be paid according to quality of yarn and fineness of reed.

Drawing-in.

Drawing-in . .	$3\frac{1}{2}d.$	per 1000 ends, with lease.
„ . .	$4\frac{3}{4}d.$	„ „ without lease.

The above is the Blackburn and district list paid less 10 per cent. Other districts have rather higher lists.

The prices in the Preston list of 1860 were as under:—

Looming or Twisting for 1000 Ends.

With a less	d.	Without a less	d.
28 to 60 inclusive .	$2\frac{1}{4}$	28 to 60 inclusive .	$3\frac{1}{4}$
61 „ 80 „ .	$2\frac{3}{8}$	61 „ 80 „ .	$3\frac{3}{8}$
81 „ 120 „ .	$2\frac{1}{2}$	81 „ 120 „ .	$3\frac{1}{2}$

Drawing-in for 1000 Ends.

With a less	d.	Without a less	d.
28 to 120 . . .	$3\frac{1}{2}$	28 to 120 . . .	$3\frac{3}{4}$

Weaving Wages.

The employers of Blackburn, Preston, and Burnley, being the principal weaving districts of Lancashire, and the representatives of the Northern Counties Weavers' Associations adopted and put in force during the past year (1892) a new uniform list of prices for plain weaving. Until this list was adopted, the most important lists were the Blackburn list of 1853 and the Burnley list of 1880 for plain cloth, and the Nelson satin list for fancy cloth. The Chorley plain and Preston lists were based on the Blackburn list, and related to a fine class of goods. The Bury, Stockport, and Ashton lists had been gradually superseded by the Blackburn list as regarded plain cloth. An attempt had been made by the operatives to combine

the Chorley fancy list and the Nelson satin list as a new list, to be called the North and North-East Lancashire fancy list, but it had not been accepted by the employers.

These two fancy lists are given here, and have been printed with the uniform list, but, as just stated, have not been officially adopted by the employers of any district.

The lists may be divided into two classes :—

(1.) Those regulating wages for weaving plain cloth.

(2.) Those regulating wages for weaving fancy cloth.

The Blackburn list was in 1883 formally adopted for the former by many districts as the chief regulating factor of Lancashire plain weavers' wages, but of course has now been superseded by the uniform list. This has been most difficult to formulate, having, it might be said, for years engaged the attention of Joshua Rawlinson, Esq., J.P., of Burnley, and Thomas Birtwistle, J.P., of Accrington, the employers' and operatives' secretaries respectively, who called in to their aid other leading representatives of both sides. Difficult of formulation, it has been still more difficult to establish, opposition having been met with from operatives in all districts where a reduction was involved. It is now estimated to cover 300,000 looms, and with the preparatory processes to regulate a wages bill of £100,000 weekly.

Since the first edition of this book was published three new lists have been adopted in addition to the uniform list. These are the Oldham velvet list of 1890, the Colne coloured goods list of 1891, and the Radcliffe coloured goods list of 1892. The latter lists were like the uniform list framed by Mr. Joshua Rawlinson and Mr. Birtwistle on behalf of, and in consultation with, the leading men on both sides.

The Radcliffe list is printed here in place of the older list that appeared in the first edition, and the Oldham and Colne lists are inserted as additional representative lists. The Oldham list refers to velvets and heavy goods. In those towns where a uniform style of goods is made of plain and comparatively simple weave, it is possible to adopt and adhere to a standard rate of payment such as is done in Burnley, Blackburn, and other towns. In other districts such as Bolton, Manchester, and Preston, the sorts are so varied and difficult to classify that at many mills a private list is adhered to.

The lists here given are:—

1. The Uniform list of weaving prices of 1892.
2. The Blackburn list of 1853.
3. The Chorley plain list of 1875.
4. The Burnley plain list of 1880.
5. The Preston list of 1860.
6. The Chorley fancy list of 1886.
7. The Nelson satin list of 1886.
8. The Radcliffe coloured goods list of 1892.
9. The Oldham velvet list of 1890.
10. The Colne coloured goods list of 1891.

1. THE UNIFORM LIST, 1892.

(1) The Standard.

The standard upon which this list is based is an ordinarily-made loom, 45 inches in the reed space, measured from the fork grate on one side to the back board on the other, weaving cloth as follows:—

Width.—39, 40, or 41 inches.

Reed.—60 reed, 2 ends in one dent, or 60 ends per inch.

Picks.—15 picks per quarter inch, as ascertained by arithmetical calculation, with 1½ per cent. added for contraction.

Length.—100 yards of 36 inches measured on the counter. Any length of lap other than 36 inches to be paid in proportion.

Twist.—28's or any finer numbers.

Weft.—31's to 100's both inclusive.

Price.—30d., or 2d. per pick.

(2) Width of Looms.

A 45-inch reed space loom being taken as the standard, 1½ per cent. shall be added for each inch up to and including 51 inches; 2 per cent. from 51 to 56 inches; 2½ per cent. from 56 to 64 inches; and 3 per cent. from 64 to 72 inches. 1¼ per cent. shall be deducted for each inch from 45 to 37 inches inclusive; and 1 per cent. from 37 to 24 inches, below which no further deduction shall be made. For any fraction of an inch up to the half no addition or deduction shall be made, but if over the half the same shall be paid as if it were a full inch. All additions or deductions under this clause to be added to or taken from the price of the standard loom, 45 inches.

Deducted from Standard.				Added to Standard.			
Loom.	Per-centage.	Loom.	Per-centage.	Loom.	Per-centage.	Loom.	Per-centage.
Inches.		Inches.		Inches.		Inches.	
24	23	35	12	46	$1\frac{1}{2}$	60	29
25	22	36	11	47	3	61	$31\frac{1}{2}$
26	21	37	10	48	$4\frac{1}{2}$	62	34
27	20	38	$8\frac{3}{4}$	49	6	63	$36\frac{1}{2}$
28	19	39	$7\frac{1}{2}$	50	$7\frac{1}{2}$	64	39
29	18	40	$6\frac{1}{4}$	51	9	65	42
30	17	41	5	52	11	66	45
31	16	42	$3\frac{3}{4}$	53	13	67	48
32	15	43	$2\frac{1}{2}$	54	15	68	51
33	14	44	$1\frac{1}{4}$	55	17	69	54
34	13	45	Standard	56	19	70	57
				57	$21\frac{1}{2}$	71	60
				58	24	72	63
				59	$26\frac{1}{2}$		

(3) Broader Cloth than Admitted by Rule.

All looms shall be allowed to weave to within 4 inches of the reed space, but whenever the difference between the width of cloth and the reed space is less than 4 inches it shall be paid as if the loom were 1 inch broader, and if less than 3 inches, as if it were $2\frac{1}{2}$ inches broader.

(4) Allowance for Cloth 7 to 15 inches Narrower than the Reed Space.

When the cloth is from 7 to 15 inches inclusive narrower than the reed space of the loom in which it is being woven, a deduction in accordance with the following tables shall be made. No further deduction shall be made when cloth is more than 15 inches narrower than

the reed space, or when cloth is narrower than 18 inches. Fractions of an inch are not to be recognised under this clause.

ALLOWANCES FOR NARROW CLOTH.

Cloth	72-in. Loom	Cloth	71-in. Loom	Cloth	70-in. Loom	Cloth	69-in. Loom	Cloth	68-in. Loom	Cloth	67-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
65	1.38	64	1.41	63	1.43	62	1.46	61	1.49	60	1.52
64	2.76	63	2.81	62	2.87	61	2.92	60	2.98	59	3.04
63	4.14	62	4.22	61	4.3	60	4.38	59	4.47	58	4.56
62	5.52	61	5.62	60	5.73	59	5.84	58	5.96	57	5.83
61	6.9	60	7.03	59	7.17	58	7.31	57	7.2	56	7.09
60	8.28	59	8.44	58	8.6	57	8.52	56	8.44	55	8.36
59	9.66	58	9.84	57	9.79	56	9.74	55	9.69	54	9.63
58	11.04	57	11.02	56	10.99	55	10.96	54	10.93	53	10.9
57	12.19	56	12.19	55	12.18	54	12.18	53	12.17	52	12.16

Cloth	66-in. Loom	Cloth	65-in. Loom	Cloth	64-in. Loom	Cloth	63-in. Loom	Cloth	62-in. Loom	Cloth	61-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
59	1.55	58	1.58	57	1.35	56	1.37	55	1.4	54	1.43
58	3.1	57	2.91	56	2.7	55	2.75	54	2.8	53	2.85
57	4.4	56	4.23	55	4.05	54	4.12	53	4.2	52	4.28
56	5.69	55	5.55	54	5.4	53	5.49	52	5.6	51	5.7
55	6.98	54	6.87	53	6.74	52	6.87	51	7.	50	7.13
54	8.28	53	8.19	52	8.09	51	8.24	50	8.4	49	8.27
53	9.57	52	9.51	51	9.44	50	9.62	49	9.51	48	9.41
52	10.86	51	10.83	50	10.79	49	10.71	48	10.63	47	10.55
51	12.16	50	12.15	49	11.87	48	11.81	47	11.75	46	11.69

Cloth	60-in. Loom	Cloth	59-in. Loom	Cloth	58-in. Loom	Cloth	57-in. Loom	Cloth	56-in. Loom	Cloth	55-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
53	1.45	52	1.48	51	1.51	50	1.54	49	1.26	48	1.28
52	2.91	51	2.96	50	3.02	49	2.78	48	2.52	47	2.56
51	4.36	50	4 45	49	4.23	48	4.01	47	3.78	46	3.85
50	5.81	49	5.63	48	5.44	47	5.25	46	5.04	45	5.13
49	6.98	48	6.82	47	6.65	46	6.48	45	6.3	44	6.09
48	8.14	47	8.	46	7.86	45	7.72	44	7.25	43	7.05
47	9.3	46	9.19	45	9.07	44	8.64	43	8.19	42	8.01
46	10.47	45	10.38	44	9.98	43	9.57	42	9.14	41	8.97
45	11.63	44	11.26	43	10.89	42	10.49	41	10.08	40	9.94

ALLOWANCES FOR NARROW CLOTH—*continued.*

Cloth	54-in. Loom	Cloth	53-in. Loom	Cloth	52-in. Loom	Cloth	51-in. Loom	Cloth	50-in. Loom	Cloth	49-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
47	1.3	46	1.33	45	1.35	44	1.03	43	1.05	42	1.06
46	2.61	45	2.65	44	2.36	43	2.06	42	2.09	41	2.12
45	3.91	44	3.65	43	3.38	42	3.1	41	3.14	40	3.18
44	4.89	43	4.65	42	4.39	41	4.13	40	4.19	39	4.25
43	5.87	42	5.64	41	5.41	40	5.16	39	5.23	38	5.13
42	6.85	41	6.64	40	6.42	39	6.19	38	6.1	37	6.01
41	7.83	40	7.63	39	7.43	38	7.05	37	6.98	36	6.9
40	8.8	39	8.63	38	8.28	37	7.91	36	7.85	35	7.78
39	9.78	38	9.42	37	9.12	36	8.77	35	8.72	34	8.67

Cloth	48-in. Loom	Cloth	47-in. Loom	Cloth	46-in. Loom	Cloth	45-in. Loom	Cloth	44-in. Loom	Cloth	43-in. Loom
in.	per cent.	in.	per cent	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
41	1.08	40	1.09	39	1.11	38	.94	37	.95	36	.96
40	2.15	39	2.18	38	2.03	37	1.87	36	1.9	35	1.92
39	3.23	38	3.09	37	2.96	36	2.81	35	2.85	34	2.88
38	4.13	37	4.	36	3.88	35	3.75	34	3.80	33	3.77
37	5.02	36	4.91	35	4.8	34	4.69	33	4.75	32	4.81
36	5.92	35	5.83	34	5.73	33	5.62	32	5.70	31	5.77
35	6.82	34	6.74	33	6.65	32	6.56	31	6.65	30	6.54
34	7.72	33	7.65	32	7.57	31	7.5	30	7.41	29	7.31
33	8.61	32	8.56	31	8.5	30	8.25	29	8.16	28	8.08

Cloth	42-in. Loom	Cloth	41-in. Loom	Cloth	40-in. Loom	Cloth	39-in. Loom	Cloth	38-in. Loom	Cloth	37-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
35	.97	34	.99	33	1.	32	1.01	31	1.03	30	.83
34	1.95	33	1.97	32	2.	31	2.03	30	1.85	29	1.67
33	2.92	32	2.96	31	3.	30	2.84	29	2.67	28	2.5
32	3.9	31	3.95	30	3.8	29	3.65	28	3.49	27	3.33
31	4.87	30	4.74	29	4.6	28	4.46	27	4.32	26	4.17
30	5.65	29	5.52	28	5.4	27	5.27	26	5.14	25	5.
29	6.43	28	6.32	27	6.2	26	6.08	25	5.96	24	5.83
28	7.21	27	7.11	26	7.	25	6.89	24	6.78	23	6.67
27	7.99	26	7.89	25	7.8	24	7.7	23	7.60	22	7.5

ALLOWANCES FOR NARROW CLOTH—*continued.*

Cloth	36-in. Loom	Cloth	35-in. Loom	Cloth	34-in. Loom	Cloth	33-in. Loom	Cloth	32-in. Loom	Cloth	31-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
29	.84	28	.85	27	.86	26	.87	25	.88	24	.89
28	1.69	27	1.7	26	1.72	25	1.74	24	1.76	23	1.79
27	2.53	26	2.56	25	2.59	24	2.62	23	2.65	22	2.68
26	3.37	25	3.41	24	3.45	23	3.49	22	3.53	21	3.57
25	4.21	24	4.26	23	4.31	22	4.36	21	4.41	20	4.46
24	5.06	23	5.11	22	5.17	21	5.23	20	5.29	19	5.36
23	5.9	22	5.97	21	6.03	20	6.1	19	6.18	18	6.25
22	6.74	21	6.82	20	6.9	19	6.98	18	7.06		
21	7.58	20	7.67	19	7.76	18	7.85				

Cloth	30-in. Loom	Cloth	29-in. Loom	Cloth	28-in. Loom	Cloth	27-in. Loom	Cloth	26-in. Loom	Cloth	25-in. Loom
in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.	in.	per cent.
23	.9	22	.91	21	.93	20	.94	19	.95	18	.96
22	1.81	21	1.83	20	1.85	19	1.87	18	1.9		
21	2.71	20	2.74	19	2.78	18	2.81				
20	3.61	19	3.66	18	3.7						
19	4.52	18	4.57								
18	5.42										

(5) REEDS.

A 60 reed being taken as the standard, $\frac{3}{4}$ per cent. shall be deducted for every two ends or counts of reed from 60 to 50, but no deduction shall be made below 50. $\frac{3}{4}$ per cent. shall be added for every two ends or counts of reed from 60 to 68; 1 per cent. from 68 to 100; $1\frac{1}{2}$ per cent. from 100 to 110; and 2 per cent. from 110 to 132. All additions or deductions under this clause to be added to or taken from the price of the standard, 60 reed.

Deducted from Standard.		Added to Standard.			
Count of Reed.	Per-centage.	Count of Reed.	Per-centage.	Count of Reed.	Per-centage.
50	3¾	62	¾	98	18
52	3	64	1½	100	19
54	2¼	66	2¼	102	20½
56	1½	68	3	104	22
58	¾	70	4	106	23½
60	Standard.	72	5	108	25
		74	6	110	26½
		76	7	112	28½
		78	8	114	30½
		80	9	116	32½
		82	10	118	34½
		84	11	120	36½
		86	12	122	38½
		88	13	124	40½
		90	14	126	42½
		92	15	128	44½
		94	16	130	46½
		96	17	132	48½

(6) Picks.

Low.—An addition of 1 per cent. shall be made for each pick or fraction of a pick below 11, thus:—

Below 11 down to and including 10, 1 per cent.
" 10 " " 9, 2 "
" 9 " " 8, 3 "
" 8 " " 7, 4 "

and so on, adding 1 per cent. for each pick or fraction thereof.

High.—An addition of 1 per cent. per pick shall be made whenever they exceed the following, if using

Weft below 26's when picks exceed 16
„ 26's to 39's inclusive „ 18
„ 40's and above „ 20

In making additions for high picks any fraction of a pick less than the half shall not have any allowance; exactly the half shall have ½ per cent. added; any fraction over the half shall have the full 1 per cent. added.

(7) Twist.

The standard being 28's, or finer, the following additions shall be made when coarser twist is woven in the following reeds:—

Below 28's to 20's in 64 to 67 reed inclusive, 1 per cent.
68 to 71 „ „ 2 „
72 to 75 „ „ 3 „
Below 20's to 14's in 56 to 59 „ „ 1 „
60 to 63 „ „ 2 „
64 to 67 „ „ 3 „

and so on at the same rate. When twist is woven in coarser reeds no addition shall be made.

(8) Weft.

Ordinary Pin Cops.—The standard being 31's to 100's both inclusive, shall be reckoned equal. Above 100's 1 per cent. shall be added for every 10 hanks or fraction thereof. In lower numbers than 31's the following additions shall be made:—

For 30's, add 1 per cent.
„ 29's, 28's, „ 2 „
„ 27's, 26's, „ 3 „
„ 25's, 24's, „ 4½ „
„ 23's, 22's, „ 6½ „
„ 21's, 20's, „ 8 „
„ 19's, 18's, „ 10½ „
„ 17's, 16's, „ 13 „
„ 15's, 14's, „ 16 „

Large Cops.—When weft of the following counts is spun into large cops so that there are not more than 19 in one pound, the following additions shall be made in place of the allowance provided for pin cops in preceding table:—

For 29's, 28's,	add 1	per cent.
,, 27's, 26's,	,, 2	,,
,, 25's, 24's, 23's,	,, 3	,,
,, 22's, 21's, 20's,	,, $4\frac{1}{2}$	,,
,, 19's, 18's,	,, 6	,,
,, 17's, 16's,	,, 8	,,
,, 15's, 14's,	,, 10	,,

(9) Four-Staved Twills.

Low Picks.—In four-staved twills an addition of 1 per cent. for each pick or fraction thereof below the picks mentioned in the following table shall be made when using weft as follows:—

Below 26's, the addition	shall	begin at	13
26's to 39's, inclusive	,,	,,	14
40's and above	,,	,,	15

High Picks.—When using weft

Below 26's, the addition for high picks	shall	begin	at	21
26's to 39's inclusive	,,	,,	,,	22
40's and above	,,	,,	,,	23

In making additions for high picks, any fraction of a pick less than the half shall not have any allowance; exactly the half shall have $\frac{1}{2}$ per cent. added; any fraction over the half shall have the full 1 per cent. added.

(10) Splits.

The following additions shall be made for splits:—

One split, uncut,	add 5	per cent.
Two splits, ,,	,, $7\frac{1}{2}$	,,

Empty dents only shall not be considered splits.

(11) Additions and Deductions.

All the foregoing additions and deductions shall be made separately.

This list is subject to a reduction of 10 per cent.

This list shall come into force after the first making-up day in August for cloths requiring a fresh calculation, and on the first making-up day in November next for all cloths.

The foregoing list has been framed at Conferences of Representatives.

Signed on behalf of the Employers,

Joshua Rawlinson,

Secretary of the North and North-East Lancashire Cotton Spinners and Manufacturers' Association.

Signed on behalf of the Operatives,

Thomas Birtwistle,

Secretary for the Northern Counties' Amalgamated Associations of Weavers.

June 24, 1892.

Additions upon Plain Cloth Prices for the following Classes have not been altered.

Doria Stripes.—Two and a half per cent. extra for doria stripes in addition to the number of ends.

Spiral Gold Headings.—1d. extra for spiral gold headings requiring 50 picks at each side, nothing for any less number of picks.

Grey Dhooties.—Seven or nine gall headings, cloth woven full width of loom, 40 inches and over, to be ¼d. for 12, ½d. for 14 headings, and 1d. for 16 to 20 marks of 40 yards. Nothing extra for headings if narrow cloth in broad looms.

Plain Dhooties.—There are two systems of paying for dhooties, but in the ultimate result there is very little difference.

The first that was adopted was as follows:—

10	yard	dhooties	10	per cent.	above list.
9	,,	,,	11	,,	,,
8	,,	,,	12	,,	,,
7	,,	,,	13	,,	,,
6	,,	,,	14	,,	,,
5	,,	,,	15	,,	,,

The second is 10 per cent. upon all lengths without any deduction being made for width of cloth.

Dobby Dhooties.—Sixteen flush ends or under, with Calcutta heading, 20 per cent.

Sixteen ends and under, with Madras heading, to be paid 30 per cent. on list.

All other dobby borders to be paid 30 per cent., with prices for headings as per illustrated coloured list, agreed upon March 15, 1886.

Dhooty Headings—Extras for 40ss Yards.—Madras heading to be paid ¼d. for 12, ½d. for 14 marks, if woven in looms over 39 inches wide, and 1d. for 16 to 20 marks, and 1½d. for 21 to 30, in whatever loom woven.

Large sarrie heading, with 1 shuttle 15 bars, to be paid 1d. extra. Small sarrie heading, with 1 shuttle 9 bars, to be paid ½d. extra.

Madras sarrie heading, with 2 shuttles 11 bars, including cord, to be paid ½d. extra.

Bombay chocolate heading, with 2 shuttle 14 bars, to be paid 1d. extra for 16 marks.

Madras chocolate heading, with 4 shuttles 18 bars, including cord, to be paid 1d. per cut extra.

Red Madras heading, with 2 shuttles 10 bars, including cord, to be paid ¼d. for 12 headings, and ½d. for 14 if woven in looms over 39 inches wide, and 1d. for 16 to 20 marks, and 1½d. for 21 to 30 in any loom.

What is known as 9-bar Bombay heading, with 1 shuttle 11 bars, to be 1d. extra for 16 marks.

Bombay chocolate heading, with 3 shuttles 14 bars, to be paid 1d. extra for 16 marks.

Ordinary Calcutta heading, with 5 bars, no extras.

Examples.—Find the weaving price under the uniform list for cloth: 39 inches wide, 40 yards of 36 inches, 58 reed, 39 wheel, 507 gear, 32's twist, 32's weft, woven in 45 inch reed space loom.

Standard for 45 in. reed space 100 yds., 2d. per pick.	
Multiplied by 40 yds. and divided by 100, equals 80d.	
Multiplied by the picks 13. (507 divided by 39 wheel gives 13 picks) . . .	10.40
Width of loom, standard.	
Reed, ¾ per cent. less than standard.	
¾ per cent. on 10.40 is .078 . . .	.078
	10.322

Picks, no allowance.

Yarns, no allowance.

The price is therefore 10.322d., unless paid below the list—*e.g.*, at present the uniform list is paid less 10

per cent. 10 per cent. on 10.322 is 1.032; deduct this from the list price and it leaves 9.29.

Ans. 9.29d.

Example No. 2.—What is the weaving price for 52¼ inch cloth woven in a so-called 55 inch loom, 33 reed, 5½ pick, 40's twist, 60's weft, 80 yards of 36 inches?

Standard for 100 yards, 2.00 per pick.	
Multiply by 80 yards and divide by 100 .	1.60
Multiply 1.60 by 5½ picks	8.80

Taking the additions and deductions in the order given in the list, 55 inch loom has 17 per cent. added to 45 inch, the standard; but in this case, as the cloth is within 3 inches of the reed space, it must be taken as if it were a 57½ inch loom. The ½ inch has not to be reckoned. The list allows 21½ per cent. for a 57 inch loom; 21½ cent. on 8.80 is 1.892.

		8.80
	Add	1.892
		10.692
Reed: no deduction below 50. 3¾ per cent. below the standard equalling .4009		.4009
		10.2911
Picks: 1 per cent. per pick or fraction of a pick below 11 to be allowed; in this case 6 per cent. . . .		.6174
		10.9085 standard.

If paid less 10 per cent., 1.098 would be deducted, leaving 9.817d.

Ans. 9.817d.

Example No. 3.—Find the weaving price for 40 inch cloth, 108 yards long, 36½ inches to the yard, 80 reed, 24 pick, 40's/60's, woven in 50 inch reed space loom.

Standard, 2d. per pick.	
The cloth in yards of 36 inches is 109½ yards long.	
109½ multiplied by 2d. and divided by 100 gives	2.19
Multiplied by 24 picks gives . . .	52.56
Loom width: the loom is 50 inch reed space, and therefore requires 7½ per cent. over standard, equalling . . .	3.922
	56.502
Narrow cloth: as the cloth is more than 7 inches narrower than the reed space, a deduction of 4.19 per cent. is allowed, equal to 2.3674	2.3674
	54.2346
Reed: the reed is above standard, and has 9 per cent. added	4.8721
	59.0067
Picks: cloth of 24 picks has 4 per cent. added	2.3692
	61.3369

If 10 per cent. be deducted, equalling 6.1366, it leaves 55.2003 as the price.

Ans. 4s. 7.2003d.

If the foregoing examples be carefully studied, and each allowance checked by the standard list to ascertain the reason why it is made, the student will soon be able to set himself similar problems, and exercise himself in the calculations by working them out without referring to a copy of the list, afterwards checking them by the list.

2. THE BLACKBURN LIST, 1853.

(1) **The Standard.**—The standard upon which this list is based is a 40-inch loom, weaving from 36 to 41 inch cloth, 60 reed Stockport counts, 16 picks per $\frac{1}{4}$ inch, $37\frac{1}{2}$ yards of 37 inches, from 30's to 60's weft, and from 28's to 45's twist for 12.25d.

(2) **Reeds.**—A 60 reed or 30 dents, being the standard, is made the starting-point, and $\frac{3}{4}$ per cent. is deducted for every two ends or counts of reeds, from 60 to 48; but no deduction is made below 48 reed, and $\frac{3}{4}$ per cent. is added for every two ends or counts of reed above 60.

(3) **Weft.**—All weft from 30's to 60's, both included, is considered medium, and reckoned equal, but all weft above 60's to be allowed 1 per cent. for every ten hanks,

and all below	30's to 26's	to be allowed	2	per cent. on list.
,,	26's to 20's	,,	5	,,
,,	20's to 16's	,,	8	,,
,,	16's to 14's	,,	10	,,

(4) **Twist.**—All twist from 28's to 45's, both included, is considered medium, and reckoned equal, but all twist above 45's up to 60's to be allowed $1\frac{1}{2}$ per cent., and all above 60's 1 per cent. for each ten hanks,

and all below	28's to 20's	to be allowed	1	per cent. on list.
,,	20's to 14's	,,	2	,,

(5) **Additions for Picks.**—All picks above 8 and up to 18 are considered proportionate, but 8 picks, and all below and all above 18, to have 1 per cent. allowed for

every pick over and above the proportionate difference in the number of picks.

(6) **Width of Looms.**—A 40-inch loom, being the standard, is taken as the starting-point, and all additions or deductions are made therefrom. (The reed space is measured from back board to forkgrate.)

26	in. loom has	$2\frac{1}{2}$	per cent.	deducted from	30	in. loom.
30	,,	5	,,	,,	35	,,
35	,,	5	,,	,,	40	,,

40-inch loom (45-inch reed space) the standard—

45	in. loom has	5	per cent.	added to	40	in. loom.
50	,,	10	,,	,,	45	,,
55	,,	10	,,	,,	50	,,
60	,,	10	,,	,,	55	,,

(7) **Looms of Intermediate Widths.**—One per cent. per inch to be deducted from 40 down to 30-inch loom; below 30 to 26-inch loom $\frac{5}{8}$ per cent. per inch to be deducted. Above 40-inch up to 45-inch loom 1 per cent. per inch to be added, and all above 45-inch 2 per cent. per inch.

(8) **Narrow Cloth in Broad Looms.**—Suppose a 40-inch loom should be weaving cloth 36 to $31\frac{1}{4}$ inches in width, take off one-half the difference between 40 and 35-inch loom price; and if weaving cloth 31 to $27\frac{1}{4}$ inches wide, take off one-half the difference between 40 and 30-inch loom price; or if weaving $41\frac{1}{4}$ to 46-inch cloth in a 50-inch loom, take off one-half the difference between 50 and 45-inch loom, and so on with all other widths.

(9) **Range of Cloths.**

26	in.	loom	allowed to weave cloth	up to 27 in.
27	,,	,,	,,	from 27 to 28 in.
30	,,	,,	,,	,, 27 ,, 31 ,,
35	,,	,,	,,	,, 31 ,, 36 ,,
40	,,	,,	,,	,, 36 ,, 41 ,,
45	,,	,,	,,	,, 41 ,, 46 ,,
50	,,	,,	,,	,, 46 ,, 52 ,,
55	,,	,,	,,	,, 52 ,, 57 ,,
60	,,	,,	,,	,, 57 ,, 62 ,,

(10) **Basis of Calculations.**—The calculations in the Blackburn list are based upon the picks counted by the glass when the cloth is laid upon the counter. Forty yards short stick to be taken as 39 yards long stick.

(11) **Adding or Deducting Percentages.**—In making calculations the allowances must be added or deducted separately in the order they are here placed, viz., reeds, materials, picks, and widths.

(12) **Splits.**—Splits to be allowed $\frac{3}{10}$d. per piece (double width) for 29 yards, or $\frac{1}{2}$d. per piece (double width) for 46 yards.

(13) **Figured Shirtings.**—Figured shirtings are paid 10 per cent. above plain cloth.

(14) **Twills.**—Plain 4-staved twills are paid same price as plain cloth. Other kinds by special arrangement.

(15) **Plain Dhooties.**—There are two systems of paying for plain dhooties, but in the ultimate result there is very little difference.

The first that was adopted was as follows:—

10	yard	dhooties	10	per cent.	above list.
9	,,	,,	11	,,	,,
8	,,	,,	12	,,	,,
7	,,	,,	13	,,	,,
6	,,	,,	14	,,	,,
5	,,	,,	15	,,	,,

The second is 10 per cent. upon all lengths without any deduction being made for width of cloth.

(16) **Dobbie Dhooties.**—On February 18, 1874, it was agreed that $\frac{5}{8}$ fluss bordered Dobbie Dhooties should be paid 30 per cent. on list without any deduction for width of cloth or additions for number of headings, the wider borders and more exceptional goods to be paid extra.

(17) **Dividend.**—The dividend of the loom is formed by adding $1\frac{1}{2}$ per cent. to the mathematical dividend for the contraction of the cloth between the loom and the counter.

(18) This list was paid in Blackburn, Darwen, Accrington, Great Harwood, Bury, Haslingden, Stalybridge, Mossley, Chorley (part), Ashton (part), Preston (part), and most weaving districts, less 10 per cent., until autumn 1892.

Example.—To find price for a 44 inch cloth in 45 inch loom = 66's reed, 44 change pinion, 528 dividend, 75 yards long, 34's/36's—

	12.25 standard.
Add $2\frac{1}{4}$ per cent. reed	.27
	12.52
Add 5 per cent. loom	.62
	13.14
Calculate in proportion to pick 16 to 12 . .	= 9.86
Calculate proportion length $37\frac{1}{2}$ to 75, double . .	= 19 72 = list price.
Deduct 10 per cent. =	1.97
	17.75 = present price.

Or from list under heading, 45 inch loom—

66 reed, 37½ yards = .822 for 1 pick
9.86 for 12 picks
19.72 for 75 yards, less 10 per cent.
= 17.75.

3. CHORLEY PLAIN LIST, 1875.

THE CHORLEY STANDARD LIST OF PRICES FOR WEAVING CAMBRICS, SHIRTINGS, AND TANJIBS.

(1) **Standard.**—45 inch reed space loom, 60 reed, Stockport counts, 37½ yards long stick, 15 picks per ¼ inch, at 11.25d., is taken as a standard, free from any allowances for materials.

(2) **Reeds.**—A 60 reed is made the starting-point, and ¾ per cent. is deducted for every 2 ends or counts of reed below a 60 to a 48, but no deduction for reeds below 48. One per cent. is added for every 2 ends above a 60 to an 84 reed, and 1½ per cent. for every 2 ends from 84 to 88, and 2 per cent. for every two ends above an 88 to 94, and 2½ per cent. for every two ends or counts of reed above 94. All odd or bastard reeds to be paid as the next finer counts—that is to say, a 77 reed to be paid as 78, and 99 as 100 reed, and so on with all other counts.

(3) **One End in a Dent.**—One end in a dent to be paid half way between the actual fineness of the reed and the number of ends—that is to say, a 96 reed would have 48 ends to the inch; therefore it would be taken as 72 reed, half way between 48 and 96.

(4) **Three or more Ends in one Dent.**—Three or more ends in one dent to be paid according to the number

of ends per inch—that is to say, a 60 reed with three ends in one dent to be paid for as a 90 reed.

(5) **Wet Weft.**—For wet weft, 1d. to be added for a piece of 25 yards.

(6) **For Width of Looms.**

31	inch loom	has	4	per cent.	deducted from	35
35	,,	,,	5	,,	,,	40
40	,,	,,	5	,,	,,	45

45 *inch Reed Space Loom is the Standard.*

50	inch loom	has	5	per cent.	added to	45
55	,,	,,	10	,,	,,	50
60	,,	,,	10	,,	,,	55
65	,,	,,	15	,,	,,	60

(7) **Measurement of Looms.**—The loom in all cases to be measured from the backboard on the one side to the fork-grate on the other side, and allowed to weave cloth within 4 inches of the width of the reed space.

(8) **Looms of Intermediate Widths.**—One per cent. per inch below 45 to 31 inch to be deducted, but no deduction to be made for looms below 31; and 1 per cent. per inch to be added from 45 to 50 inches, and 2 per cent. per inch from 50 to 60 inches, and 3 per cent. per inch for all above.

(9) **Percentage for Picks.**—All picks above 9, and up to 18, are considered proportionate; but 9 picks and all below, and all above 18, to have 1 per cent. added for every pick over and above the proportion. All under the half not to be paid for, but all above the half to be paid for as full picks; if exactly the half pick, $\frac{1}{2}$ per cent. only to be paid above the proportionate part.

(10) **Range of Cloth.**

31	inch	reed	space	loom,	to	weave	cloth up to	27 inch.
32	,,	,,	,,		from	27	,, 28	,,
33	,,	,,	,,		,,	27	,, 29	,,
34	,,	,,	,,		,,	27	,, 30	,,
35	,,	,,	,,		,,	27	,, 31	,,
36	,,	,,	,,		,,	27	,, 32	,,
37	,,	,,	,,		,,	28	,, 33	,,
38	,,	,,	,,		,,	29	,, 34	,,
39	,,	,,	,,		,,	30	,, 35	,,
40	,,	,,	,,		,,	31	,, 36	,,
41	,,	,,	,,		,,	32	,, 37	,,
42	,,	,,	,,		,,	33	,, 38	,,
43	,,	,,	,,		,,	34	,, 39	,,
44	,,	,,	,,		,,	35	,, 40	,,
45	,,	,,	,,		,,	36	,, 41	,,
46	,,	,,	,,		,,	37	,, 42	,,
47	,,	,,	,,		,,	38	,, 43	,,
48	,,	,,	,,		,,	39	,, 44	,,
49	,,	,,	,,		,,	40	,, 45	,,
50	,,	,,	,,		,,	41	,, 46	,,

(11) **Narrower Cloth than Table admits.**—Suppose a 50 inch loom should be weaving cloth from 36¼ to 41 inches in width, then take off one-half the difference between 50 and 45 inch looms; and if weaving from 31¼ to 36 inch cloth, take off one-half the difference between 50 and 40 inch looms; or if weaving 33¼ to 38 inch cloth in 47 inch loom, take off half the difference between 42 and 47 inch looms, and so on with any other width.

(12) **Broader Cloth than Table admits.** — Any broader cloth than table admits to be paid half the difference between that and the next broader range of looms—thus, 42 inch cloth woven in a 45 inch loom to be paid half the difference between 45 and 50 inch looms;

and if 34 inch cloth be woven in 37 inch looms, to be paid half the difference between 37 and 42 inch loom price, and so on with all other widths.

(13) **Twills.**—Four-stave plain twills to be paid same price as plain cloth.

(14) **Adding or Deducting Percentages.**—In making the above calculations, the allowances for reeds, picks, width of loom, widths of cloth, and wet weft, are taken and added or deducted, separately, in the order they are here placed, viz., first, reeds; second, picks; third, width of loom; fourth, width of cloth; and fifth, wet weft.

(15) **Calculations to be made from Decimal Pick.**—In making out prices from this list the decimal pick as produced by dividing the dividend by the change wheel is to be taken instead of the net pick; the dividend to be formed by adding $1\frac{1}{2}$ per cent. to the wheel calculation for contraction of the cloth between the loom and the counter.

(16) **Rising and Falling of Prices below 77 Reed.**—This list of prices, up to and including 76 reed, is considered $2\frac{1}{2}$ per cent. below the Blackburn standard list, and when the list is paid net at Blackburn, this list shall be paid in Chorley with $2\frac{1}{2}$ per cent. added, and any rise or fall at Blackburn shall be immediately followed by the same advance or reduction at Chorley, up to and including the 76 reed.

(17) **Rising and Falling of Prices above 76 Reed.**—This list of prices, above 76 reed, shall be considered equal to the Preston standard list, and when the list is paid net at Preston, this list shall be paid net in Chorley,

and when any advance or reduction is paid upon the list at Preston, the same advance or reduction shall be paid on this list at Chorley, above 76 reed.

The above list is now largely merged into the Uniform List.

4. THE BURNLEY PLAIN LIST, 1880.

For Weaving Printers, Shirtings, Madapallams, Jacconet, Mulls, and Tanjibs.

(1) **Standard.**—Two shillings and sixpence is taken as the standard for 39 inch cloth, 60 reed, Stockport counts (or 60 ends per inch), 100 yards long stick, 15 picks per ¼ inch, woven in a loom of 43 inches reed space, measured from backboard to fork-grate. 19½ yards long stick to be taken as 20 yards short stick.

(2) **Reed.**—A 60 reed being the standard, ¾ per cent. shall be deducted for every two ends or counts of reed, from 60 to 52, but no deduction shall be made below 52. ¾ per cent. shall be added for every two ends from 60 to 68, and above 68, 1 per cent. for every two ends.

(3) **Counts of Yarn.**

Weft.

From	30's	to 60's	inclusive shall be reckoned equal.		
,,	30's	,, 26's	2 per cent.	shall be added to standard.	
,,	26's	,, 20's	5	,,	,,
,,	20's	,, 16's	8	,,	,,
,,	16's	,, 14's	10	,,	,,

Weft above 60's shall have 1 per cent. added for every 10 hanks.

TWIST.

From 28's to 45's inclusive shall be reckoned equal.
,, 45's ,, 60's 1½ per cent. shall be added to standard.
,, 28's ,, 20's 1 ,, ,, ,,
,, 20's ,, 14's 2 ,, ,, ,,

Twist above 60's shall have 1 per cent. added for every 10 hanks.

(4) **Picks.**—Picks between and including 13 and 20 are considered proportionate, but each pick below 13 and above 20 shall have 1 per cent. added for each pick below 13 or above 20 respectively. Picks shall be paid for as ascertained by calculations given in Clause 11; but with reference to the additional percentage, if under the half pick, nothing extra shall be paid; if above the half, 1 per cent. shall be paid as if it were a full pick; but if exactly the half pick, ½ per cent. shall be paid. For example, 21.49 pick shall have 1 per cent. added; 21.51, 2 per cent. added; but if exactly 21.5, 1½ per cent. shall be added.

(5) **Width of Looms.**—A 43 inch reed space loom being taken as the standard, 1½ per cent. per inch shall be deducted from 43 to 36 inch reed space, and 1 per cent. per inch from 36 down to 30, but no deduction shall be made below 30 inch. 1½ per cent. per inch shall be added from 43 to 45 inch reed space, and 2 per cent. per inch above.

(6) **Narrow Cloth in Broad Looms.**—All looms shall be allowed to weave cloth within 4 inches of the breadth of the reed space, measured from backboard to fork-grate. When the cloth is 6 inches narrower than the reed space, ¾ per cent. shall be deducted, and so on at the rate of

$\frac{3}{4}$ per cent. per inch until the width of cloth be 15 inches below the breadth of reed space, when no further deduction shall be made.

(7) **Broad Cloth in Narrow Looms.**—When the difference between the cloth and the reed space is less than 4 inches, for the first inch or fraction of an inch, the same shall be paid as if the loom were 1 inch broader, and if within three inches of the reed space, as if the loom were 2 inches broader.

(8) **Throstle Twist.**—In reeds above 68 a deduction of $2\frac{1}{2}$ per cent. shall be allowed for throstle twist.

(9) **Twills.**—Four-stave twills shall be paid same as plain cloth except in allowances for picks, when all picks 15 and up to 24 shall be considered proportionate, but each pick below 15 and above 24 shall have 1 per cent. added below or above the proportion.

(10) **Headings.**—This list shall only apply to printers, shirtings, madapallams, jacconets, mulls, and tanjibs; but when more than 9 picks of gold for a single piece, or any other heading out of the usual course for the above classes of goods shall be put in, an extra price shall be paid as per special arrangement, but in no case less than $\frac{1}{8}$d. per piece.

(11) **Dividend.**—The actual dividend for calculation shall be formed by adding $1\frac{1}{2}$ per cent. for contraction of the cloth between the loom and the counter to the dividend produced by the beam and wheel calculation.

(12) **General.**—(*a*) The width and length of cloth shall be deemed to be the width and length at which it is bought and sold.

(*b*) In making calculations from this list the additions

or deductions for reeds, counts, picks, width of loom, width of cloth, and throstle twist shall be made separately, in the order here given.

(*c*) This list shall come into force on the second pay day in March 1880, and if either employers or operatives desire to make any change in the various clauses, they shall give to the other party three months' notice of such desire.

(*d*) The existing rate of wages being 15 per cent. less than the list, the three months' notice shall not apply to any rise or fall in the rate of wages, but merely to a desired change in the details or conditions of the list.

Example.—Find price for 39 inch, 68 reed, 75 yards, 17 picks per ¼ inch, 50's/70's, 43 inch loom.

Standard for 100 yards	30.00
Proportion for 75 ,, . . .	22.5
Add for reed 3 per cent.	.67
	23.17
Proportion 15 to 17 picks . . .	26.26
Add for counts of twist 1½ per cent. and weft 1 per cent. = 2½ per cent. .	.65
	26.91

This, less 10 per cent., the current discount off list, was the price payable in Burnley and district until autumn 1892, when it was merged into the Uniform List to a great extent. It is still paid, less 10 per cent., in some outside districts.

5. PRESTON PLAIN AND FANCY LIST, 1860.

For Shirtings, Cambrics, and Tanjibs.—(1) 45 inches reed space loom, 60 reed Stockport counts, 37½ yards

long stick, 37 inches to the yard, 60 picks per inch at 11d. per piece, is taken as a standard.

(2) **Reeds.**—1½ per cent. is deducted for every 4 ends below a 60 to a 48. All reeds below to be paid the same as a 48. 1½ per cent. is added for every 4 ends above a 60 to a 76; 3 per cent. for every 4 ends above a 76 to a 90; 5 per cent. for every 4 ends above a 90 to 100; and 4 per cent. for every 4 ends above 100.

(3) **Picks.**—All picks from 9 to 18 per ¼ inch inclusive are reckoned in equal ratio. One per cent. is added for each pick below 9 and above 18, up to the extent of list, and 1½ per cent. per pick to be added for all above the list in 66 to 86 reeds inclusive.

(4) **Materials.**—All yarns below 28's to be allowed 2 per cent. for every 5 hanks, and any other deviation from list counts to have 2½ per cent. added for every 5 hanks.

Twills.—To be paid the same as plain cloth.

For wet weft 1d. to be added for a piece of 25 yards.

For Jacconets and Mulls.—(1) 46 inches reed space loom, 60 reed Stockport counts, 20 yards short stick, 36 inches to the yard, 60 picks per inch, at 6d. per piece, is taken as a standard.

(2) **Reeds.**—1½ per cent. is deducted for every 4 ends below a 60 to a 48. All reeds below to be paid the same as a 48. 1½ per cent. is added for every 4 ends above a 60 to a 68, 4 per cent. for every 4 ends above a 68 to 110, and 6 per cent. for every 4 ends above 110.

(3) **Picks.**—All picks from 9 to 18 per ¼ inch inclusive are reckoned in equal ratio, and 1 per cent. is added for each pick below 9 and above 18.

(4) **Materials.**—1½ per cent. to be added for every 10 hanks the yarns are finer than list counts up to 80 reed, but no allowance on jacconet yarns above 80 reeds.

For wet weft ½d. to be added for a 20 yards piece.

For Fancy Goods.—(1) **Hair Cords** to be paid 40 per cent. over jacconet prices.

(2) **Satin Stripes with Spots** to be paid by the annexed list without receiving any advance with plain cloth.

(3) **Spots and Unfigured Satins** woven in spot looms to be paid 10 per cent. more than plain cloth.

(4) **Brocades** woven with a double lift machine to be paid 40 per cent. more than plain cloth.

(5) **Brocades** woven with a single lift machine, with a satin ground, to be paid 30 per cent. more than plain cloth.

(6) **Brocades** woven with a single lift machine, with a plain ground, to be paid 50 per cent. more than plain cloth.

(7) **Cloth** woven with 3 ends in a dent to be reckoned half way between the actual fineness of the reed and what it would be if 2 ends only were in a dent.

No allowance to be made for yarns on fancy cloth.

General Conditions.—Narrow Cloth woven in a broad loom to be paid half the difference between the price of broad and narrow cloth, and any cloth broader than table admits to be paid half the difference between that and the next broader loom.

Looms of Intermediate Widths.—One per cent. per inch to be deducted on looms below 45 inches, 2 per

cent. per inch from 45 to 60 inches, and $1\frac{1}{2}$ per cent. per inch for all above.

The annexed tables are based upon the count of picks and breadth of cloth when laid upon the counter, and in fixing the rate of wages to be paid for weaving any sort of cloth, the picks to be calculated by the wheels as shown on the table.

Atherton's Gear.—Beam wheel, 80; stud wheel, 120; rack wheel, 60; pinion wheel, 15; emery beam, 15 inches; dividend, 640.

Atherton's Gear.—Beam wheel, 80; stud wheel, 146; rack wheel, 60; pinion wheel, 14; emery beam, 15 inches; dividend, $834\frac{285}{1000}$.

Atherton's Gear.—Beam wheel, 100; stud wheel, 146; rack wheel, 60; pinion wheel, 14; emery beam, 15 inches; dividend, $1042\frac{857}{1000}$.

Dickinson's Gear.—Beam wheel, 75; stud wheel, 120; rack wheel, 50; pinion wheel, 15; emery beam, 15 inches; dividend, 500.

Dickinson's Gear.—Beam wheel, 75; stud wheel, 120; rack wheel, 80; pinion wheel, 15; emery beam, 15 inches; dividend, 800.

Harrison's Gear.—Beam wheel, 75; stud wheel, 100; rack wheel, 50; pinion wheel, 12; emery beam, 15 inches; dividend, $520\frac{5}{6}$.

32 inch reed space loom to have $12\frac{1}{2}$ per cent. deducted from standard.

36 inch reed space loom to have 10 per cent. deducted from standard.

41 inch reed space loom to have 5 per cent. deducted from standard.

46 inch reed space standard to weave from 36¼ to 41 inch cloth.

51 inch reed space loom to have 5 per cent. added to standard.

56 inch reed space loom to have 15 per cent. added to standard.

61 inch reed space loom to have 25 per cent. added to standard.

66 inch reed space loom to have 35 per cent. added to standard.

72 inch reed space loom to have 45 per cent. added to standard.

The Reed Space in all cases to be measured from backboard to backboard, and the loom allowed to weave cloth within 5 inches of the breadth of the reed space. For the Preston prices for winding, looming, drawing, &c., see earlier pages.

6. CHORLEY FANCY LIST, 1886.

(*This list to apply to grey goods only.*)

Double Lift Jacquards.—To be paid the following over and above plain cloth prices:—

For plain grounds, 30 per cent.
„ satin „ 25 „

When single lift machines are used, the scale shall be 10 per cent. higher than the above.

Brocades, damasks, and stripes created by a variation of the number of ends, 3, 4, or more in a dent, to be paid for by the number of ends per inch.

Picks 18 to 30, 1 per cent. per pick, from 30 to 40, ¾ per cent., all above 40 ½ per cent. instead of 1 per cent.

Lace brocades 5 per cent. extra.

Leno Cloths and Velvets.—Not to be included in this list, but paid extra as per arrangement.

The above applies to jacquards only.

Dobby and Tappet Motions, Sateens Excepted.—To be paid the following on plain cloth prices:—

All up to and including—

4	staves	12	per cent.	13	staves	21	per cent.
5	,,	13	,,	14	,,	22	,,
6	,,	14	,,	15	,,	23	,,
7	,,	15	,,	16	,,	24	,,
8	,,	16	,,	17	,,	25	,,
9	,,	17	,,	18	,,	26	,,
10	,,	18	,,	19	,,	27	,,
11	,,	19	,,	20	,,	28	,,
12	,,	20	,,				

Stripes and other cloths, with more than 2 ends in a dent, to be paid for by the number of ends per inch.

Exceptions.—Plain handkerchiefs, 72 reeds and below, to be paid 5 per cent. extra.

Single shuttle cord checks, with more than two picks in one shed, to be paid $2\frac{1}{2}$ per cent. less.

In single shuttle checks, handkerchiefs, and all other special classes of goods in which more than one pick is put in one shed, all lost picks shall be counted.

Lace stripes, fly overs, or any other goods of a special character shall be paid extra as per arrangement, to be agreed upon by the employers' and operatives' associations.

Sateens, Drillettes, and Drills.—When reed and pick per $\frac{1}{4}$ inch added together do not make more than 40, 5 per cent. shall be added to plain cloth prices.

When reed and pick per ¼ inch do not exceed 50, 2½ per cent. shall be added; above 50, plain cloth prices, excepting when the number of ends per ¼ inch in the reed exceeds the pick, then ¾ per cent. additional shall be added for every two points of the reed above the pick.

In case of any special cloth, either dobby or jacquards, being required for which this list is not adapted, the price shall be arranged by the employers' and operatives' associations.

7. NELSON SATIN LIST, 1886.

Agreement for Sateens, Drills, and Drillettes.

Cloths up to and including 25 picks to be paid 8 per cent. on plain cloth prices, and for every additional pick or fraction beyond the half, an extra ½ per cent. shall be added. These additions to be made in place of the allowances for picks in the various lists.

Whenever the reed per ¼ inch exceeds the pick, ¾ per cent. shall be added for every additional two counts of reed above the number of picks.

When cloth is woven with three or more ends in a dent, the allowance for every two ends or counts of reed above 68 shall only be ¾ per cent. same as from 60 to 68.

Lenos.—For one doup 70 per cent.; two doups, 80 per cent. on plain cloth prices.

8. THE RADCLIFFE AND DISTRICT LIST FOR COLOURED GOODS.

(1) Standard.

Cloth.—The list shall be based on cloth, 36 inches to the yard, and 100 yards long.

Reed.—56 reed, *i.e.*, 28 dents to the inch and two ends in a dent.

Width.—27 to 30 inches measured on the counter in an unfinished state as it comes from the loom.

Weft.—20's or any finer counts.

Shuttles.—Two.

Looms.—Drop box.

Warps.—Full (or hand) dressed or sectional warps.

Price per Pick, per $\frac{1}{4}$ inch.—3.4d. or 3d. and two-fifths, as ascertained by wheel calculation with $1\frac{1}{2}$ per cent. added for contraction.

Extras and Deductions.

(2) Reeds.

Standard.—56 reed, *i.e.*, 28 dents to the inch, and 2 ends in a dent.

Additions.—Above 28 to 35 dents, add 1 per cent. for each extra dent above 28, and above 35 dents add $1\frac{1}{2}$ per cent. for each extra dent.

Deductions.—Below 28 dents down to and including 25 dents, deduct 1 per cent. per dent, and below 25 to 20, $\frac{3}{4}$ per cent. for each dent, beyond which no further deduction shall be made.

(3) Width of Cloth.

Standard.—27 to 30 inches.

Additions.—Above 30 inches up to and including 36 inches, add 1 per cent. per inch; above 36 inches to 40 inches, add $1\frac{1}{2}$ per cent. per inch; above 40 inches to 48 inches, $2\frac{1}{2}$ per cent. per inch; and above 48 inches, 3 per cent. per inch.

Deductions.—For each inch below 27, deduct ¾ per cent. per inch down to 24 inches, beyond which no further deductions shall be made.

(4) Weft.

No addition or deduction to be made for weft finer than 20's, but for

19's, 18's, 17's	add 1 per cent.
16's, 15's	add 2 per cent.
14's	„ 4 „
13's	„ 6 „
12's	„ 8 „
11's	add 11 per cent.
10's	„ 14 „
9's	„ 18 „
8's	„ 22 „
7's	„ 26 „
6's	„ 30 „
5's	„ 35 „
4's	„ 40 „

(5) Linen Weft.

No addition or deduction to be made for 35's linen weft or any finer counts.

But for	34's to 30's	linen	add	2	per cent.
„ „	29's to 25's	„	„	4	„ „
„ „	24's to 20's	„	„	8	„ „
„ „	19's and 18's	„	„	10	„ „
„ „	17's and 16's	„	„	12	„ „

(6) Coarse Twist in a Fine Reed.

Below 16's in a 68 or finer reed (2 threads in a dent), 2 per cent. per count to be added. 14's two-fold yarn, that is, 2/28s, to be paid as 16's, and so on in proportion.

(7) Undressed Warps.

Ordinary half-beer warps, dyed, sized or bleached in the warp, to be paid extra as follows :—

All one colour	.035 per yd.
Two colours, white or grey counted	.045 „
Three „ „ „	.055 „
Four „ „ „	.075 „

increasing .02 per yard for each additional colour, selvages not reckoned a colour. Warps wound on so as to avoid crossing or splitting of half-beers in weaving, to be paid .035 per yard.

(8) Half Dressed Warps.

All warps run through a reed, but neither dressed nor brushed by hand, and when broken threads are not found and pieced in the usual way, shall be considered half dressed warps, and paid as follows:—

All one colour	.02 per yd.
Two colours, white or grey counted	.03 „
Three „ „ „	.04 „
Four „ „ „	.05 „

(9) Round Mill Warps.

All warps made on a round mill, irrespective of colours, shall be paid 5 per cent. extra.

(10) Shuttles.

For each shuttle above two, $2\frac{1}{2}$ per cent. shall be added, *i.e.*, for

3 shuttles	$2\frac{1}{2}$ per cent.
4 shuttles	5 „ „
5 shuttles	$7\frac{1}{2}$ „ „
6 shuttles	10 „ „

(11) One Shuttle Work.

Cloth woven in a one shuttled loom running not less than 170 picks per minute shall be 25 per cent. less than two-shuttle price, and if slower than 170 picks shall be 12½ per cent. less in place of 25 per cent.

(12) One Shuttle Work in Check Looms.

One shuttle work woven in check looms shall be paid 12½ per cent. less than two shuttle price.

(13) Shaft Work.

Extra payment shall be made for shaft work, such payment to cover and include pick finding, at the following rate :—

3, 4, 5, 6	lifts or treads	add	5	per cent.
7, 8, 9	,,	,,	7½	,,
10	,,	,,	10	,,
11, 12, 13, 14	,,	,,	14	,,
15, 16, 17, 18	,,	,,	18	,,

increasing 1½ per cent. for each additional lift or tread.

(14) Two Beams.

All cloth woven with two beams shall be paid not less than 7½ per cent. extra.

(15) Splits.

Cloths woven 2 or more in a breadth with selvages worked by a catch end shall be paid 3 per cent. extra for 1 split, and 5 per cent. for 2 splits.

If empty dents only are used, no extra charge shall be made.

(16) Three or more Threads in one Dent.

When the number of lifts used are equal to the number of threads in a dent, the reed to be paid for shall be found as follows :—

For 3 threads in one dent add 25 per cent.
„ 4 „ „ „ 50 „
„ 5 „ „ „ 75 „
„ 6 „ „ „ 100 „

to the actual reed used, Stockport counts, 2 ends in 1 dent.

Example.—A reed 20 dents per inch, 3 ends in each dent, shall be paid for as 25.

20 reed, 4 in a dent as 30
20 „ 5 „ „ 35 reed, and so on.

When the number of lifts used are not equal to the number of threads in each dent, the reed to be paid for shall be found as follows :—

For 3 ends in one dent add $37\frac{1}{2}$ per cent.
„ 4 „ „ „ 75 „
„ 5 „ „ „ $112\frac{1}{2}$ „
„ 6 „ „ „ 150 „

to the actual reed used, Stockport counts, 2 ends in one dent.

Example.—A reed 20 dents per inch, 3 ends in each dent, as a $27\frac{1}{2}$;

the same reed with 4 in a dent as 35
„ „ 5 „ „ $42\frac{1}{2}$
„ „ 6 „ „ 50 reed, and so on.

Provided always that in no case shall a lower reed than 26 be paid for.

(17) One Thread in a Dent.

One thread in a dent shall be paid for as if the reed were half way between the actual number of threads per inch, and what it would be if there were 2 threads in a dent.

Example.—What is known as an 80 reed, 40 dents per inch, 1 thread in a dent, would be paid for as 60 reed, 30 dents per inch, 2 ends in each dent.

(18) More than one Thread in a Heald.

(*a.*) Two threads shall be counted as one if in same heald.

(*b.*) Three or more threads in a heald and one heald to a dent, nothing extra shall be paid.

(*a.*) All cloths with either 3, 4, 5, or 6 threads in a heald, and 2 healds to a dent, an addition of $7\frac{1}{2}$ per cent. shall be paid.

(19) Circular Box Looms.

When circular box looms are used a deduction of 10 per cent. shall be made from the standard, and clause 10 shall not apply.

(20) Additions and Deductions.

In calculating the list all the above additions and deductions shall be made separately.

(21) General.

(*a.*) Should any dispute arise as to the interpretation of any of the conditions or clauses, or as to the price to

be paid for weaving any exceptional goods, a meeting of the two committees (employers and employed), shall be held with a view to an amicable settlement thereof before any strike takes place.

(*b.*) This list shall come into force for all new sorts put in the looms after the first making-up day in May 1892, and for all classes of cloth on the first making-up day in July 1892.

(*c.*) If either employers or operatives desire to make any change in the various clauses, they shall give to the other party three months' notice of such desire.

The foregoing list has been framed by a joint committee consisting of representatives of employers and operatives, and was finally adopted at a meeting held at Manchester on Friday the 29th day of April 1892, after having been approved by a general meeting of the members of the Radcliffe and District Manufacturers' Association, and approved by the operative weavers by means of a ballot.

Signed on behalf of the Employers,

JOSHUA RAWLINSON,
Secretary.

Signed on behalf of the Operative Weavers,

THOMAS BIRTWISTLE.

9. THE OLDHAM VELVET LIST.

A List applying to the Weaving of Velvets, Cords, and such Heavy Goods, put in operation October 1, 1890.

Basis.—

45 and 49	looms	weaving	56's	weft,	7d. per lb.
50 „ 54	„	„	„		$6\frac{13}{16}$d. „
55 „ 59	„	„	„		$6\frac{11}{16}$d. „
60 „ 64	„	„	„		$6\frac{9}{16}$d. „
65 „ 69	„	„	„		$6\frac{1}{2}$d. „
70 „ 74	„	„	„		$6\frac{3}{8}$d. „
75 „ 79	„	„	„		$6\frac{1}{4}$d. „
80 „ 84	„	„	„		$6\frac{1}{8}$d. „
85 „ 89	„	„	„		6d. „

Whenever the looms are narrower than the above table, $\frac{3}{16}$d. per lb. shall be added for each range of 5 inches, and if broader $\frac{1}{8}$d. per lb. shall be deducted for each similar range.

Measurement of Looms.—The loom in all cases to be measured from lathe sword to lathe sword, except looms that have a fork attached; in such case they shall be measured from lathe sword to fork-grate.

Lost Pick.—Whenever the yarn in the reed in a loom 64 inches or narrower stands more than 2 inches less than the width of the loom, $\frac{1}{16}$d. per lb. for each inch, or fraction thereof, shall be added, and in looms above 64 inches, whenever the yarn stands more than 3 inches below the width of the loom, the same allowance per inch shall be made, but no deductions shall be made for over-widths.

Allowances for Weft.—56's weft is taken as the

standard, and $\frac{1}{8}$d. per lb. shall be added or deducted for each hank as the weft is finer or coarser.

Extras.—Ribbed edges $\frac{1}{8}$d. per lb. extra.

Cloth with over 24 picks to the round $\frac{1}{8}$d. per lb. extra.

E 3 patents, $\frac{1}{8}$d. per lb. extra.

X and XX superfine twill backs up to and including 88 reed, $\frac{1}{4}$d. per lb. extra; above 88 reed and up to and including 96 reed, $\frac{1}{2}$d. per lb. extra; and for each additional 6 ends per inch or counts of reeds, $\frac{1}{4}$d. per lb. extra.

Velvet cords $\frac{1}{16}$d. per lb. extra.

Stripes $\frac{3}{8}$d. per lb. extra.

Checks $\frac{1}{2}$d. per lb. extra.

General.—This list for velvets was agreed on between the Oldham velvet manufacturers and the weavers' representatives, at a meeting held May 3, 1888, when it was also agreed:—"That the basis with allowances for weft only should come into operation on the first pay-day in June 1888. The conditions for lost pick and all other extras being suspended for the present. The time for them to come into operation to be considered at a future meeting."

SAMUEL ANDREW,
Employers' Secretary.

ABRAHAM BUCKLEY,
Operatives' Secretary.

May 17, 1888.

This list is now paid net with the above exceptions.

January 1, 1890.

OLDHAM PRICE LIST FOR WEAVING VELVETS.

Counts of Weft.	44's.	46's.	48's.	50's.	52's.	54's.	56's.	58's.	60's.	62's.	64's.
Loom. in. in.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*
25 and 29	$6\frac{1}{4}$	$6\frac{1}{2}$	$6\frac{3}{4}$	7	$7\frac{1}{4}$	$7\frac{1}{2}$	$7\frac{3}{4}$	8	$8\frac{1}{4}$	$8\frac{1}{2}$	$8\frac{3}{4}$
30 „ 34	6 1-16	6 5-16	6 9-16	6 13-16	7 1-16	7 5-16	7 9-16	7 13-16	8 1-16	8 5-16	8 9-16
35 „ 39	$5\frac{7}{8}$	$6\frac{1}{8}$	$6\frac{3}{8}$	$6\frac{5}{8}$	$6\frac{7}{8}$	$7\frac{1}{8}$	$7\frac{3}{8}$	$7\frac{5}{8}$	$7\frac{7}{8}$	$8\frac{1}{8}$	$8\frac{3}{8}$
40 „ 44	5 11-16	5 15-16	6 3-16	6 7-16	6 11-16	6 15-16	7 3-16	7 7-16	7 11-16	7 15-16	8 3-16
45 „ 49	$5\frac{1}{2}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$	$6\frac{1}{2}$	$6\frac{3}{4}$	7	$7\frac{1}{4}$	$7\frac{1}{2}$	$7\frac{3}{4}$	8
50 „ 54	5 5-16	5 9-16	5 13-16	6 1-16	6 5-16	6 9-16	6 13-16	7 1-16	7 5-16	7 9-16	7 13-16
55 „ 59	5 3-16	5 7-16	5 11-16	5 15-16	6 3-16	6 7-16	6 11-16	6 15-16	7 3-16	7 7-16	7 11-16
60 „ 64	5 1-16	5 5-16	5 9-16	5 13-16	6 1-16	6 5-16	6 9-16	6 13-16	7 1-16	7 5-16	7 9-16
65 „ 69	5	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$	$6\frac{1}{2}$	$6\frac{3}{4}$	7	$7\frac{1}{4}$	$7\frac{1}{2}$
70 „ 74	$4\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{7}{8}$	$6\frac{1}{8}$	$6\frac{3}{8}$	$6\frac{5}{8}$	$6\frac{7}{8}$	$7\frac{1}{8}$	$7\frac{3}{8}$
75 „ 79	$4\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$	$6\frac{1}{2}$	$6\frac{3}{4}$	7	$7\frac{1}{4}$
80 „ 84	$4\frac{5}{8}$	$4\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{7}{8}$	$6\frac{1}{8}$	$6\frac{3}{8}$	$6\frac{5}{8}$	$6\frac{7}{8}$	$7\frac{1}{8}$
85 „ 89	$4\frac{1}{2}$	$4\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$	$6\frac{1}{2}$	$6\frac{3}{4}$	7

Put in force October 1, 1890.

10. THE COLNE AND DISTRICT LIST FOR COLOURED GOODS.

(1) The Standard.

The standard upon which the price for **plain** and **striped** goods is based is as follows:—

Cloth.—28, 29, or 30 inches in width.

Reed.—52 to 64 both inclusive, or 26 to 32 dents per inch, 2 ends in a dent.

Length.—74 yards of warp, 36 inches to the yard.

Weft.—16's or any finer counts.

Price.—1½d. per pick.

The standard upon which the price for **checks** is based is 70 yards of warp, 2d. per pick; in all other particulars the same as the standard for plain and striped goods.

(2) Reeds.

Reeds.—52 to 64 inclusive, or 26 to 32 dents per inch, 2 ends in a dent, being taken as the standard.

Add.—Above 64 to 70, 2 per cent., above 70 an additional 1 per cent. for each extra dent or 2 ends per inch.

Deduct.—Below 52 down to and including 46, 2 per cent., and below 46, 3 per cent., beyond which no further deduction shall be made.

(3) Cloth.

The standard, being 28, 29, or 30 inches is reckoned equal.

For each inch below 28, ¾ per cent. is to be deducted down to 20 inches, beyond which no further reduction shall be made.

Above 30 inches up to and including 36, 1 per cent. per inch is to be added. Above 36 to 40, 1½ per cent., and above 40, 2½ per cent. per inch.

(4) Undressed Warps.

Ordinary half-beer warps, dyed, sized, or bleached in the warp, to be paid extra as follows:—

All one colour	.	.	.	.	.035 per yd.
Two colours, white or grey counted					.045 ,,
Three	,,	,,	,,		.055 ,,
Four	,,	,,	,,		.075 ,,

increasing .02 per yard for each additional colour, selvages not reckoned a colour. Warps wound on so as to avoid crossing or splitting of half-beers in weaving, to be paid .035 per yard.

(5) Half Dressed Warps.

All warps run through a reed, but neither dressed nor brushed by hand, and when broken threads are not found and pieced in the usual way, shall be considered half dressed warps, and paid as follows:—

All one colour	.	.	.	.	.02 per yd.
Two colours, white or grey counted					.03 ,,
Three	,,	,,	,,		.04 ,,
Four	,,	,,	,,		.05 ,,

(6) Coarse Twist in a Fine Reed.

Below 16's in a 68 or finer reed (2 threads in a dent), 2 per cent. per count to be added. 14's twofold yarn, that is, 2/28s. to be paid as 16's, and so on in proportion.

(7) Weft.

No addition or deduction to be made for weft finer than 15's.

15's add 2 per cent.	11's add 11 per cent.
14's ,, 4 ,,	10's ,, 14 ,,
13's ,, 6 ,,	9's ,, 18 ,,
12's ,, 8 ,,	8's ,, 22 ,,

Hank Weft.—Hank weft woven into plain or striped goods from tubes or bobbins shall be paid 5 per cent. extra.

(8) Shaft Work with Dobbies.

No extra payment shall be made for cloths woven with 6 or any less number of lifts or treads that can be worked with tappets although dobbies are used.

All cloths woven with dobbies that cannot be worked with tappets to be paid extra as follows:—

Up to and including 10 lifts or treads add 10 per cent.
11 to 14 lifts or treads inclusive ,, 14 ,,
15 to 18 ,, ,, ,, ,, 18 ,,

increasing 1½ per cent. for each additional lift or tread.

(9) Pick Finding in Looms Without Dobbies.

Whenever the employer requires the weaver, in cloth with 3 or more lifts or treads, to turn the loom backward or forward in order to find the shed in which the weft broke, he shall pay an advance of 10 per cent.

(10) Additions and Deductions.

All the above additions and deductions shall be made separately.

(11) General.

This list shall come into force after the first making-up day in September next for new classes of cloth, and for all classes of cloth to which it applies on the first making-up day in November. If any dispute should arise as to the interpretation of any of the previous conditions or clauses, or as to the price to be paid for weaving any goods, a meeting of the two committees (employers and employed) shall be held with a view to an amicable settlement thereof before any strike takes place.

The foregoing list was unanimously adopted at a joint meeting of committees representing employers and operatives, held at Colne on Thursday the 26th day of June 1890, and finally settled between the two secretaries at a conference held on July 16, 1890.

Signed on behalf of the Employers,

Joshua Rawlinson,
Secretary of the Colne & District Coloured Goods Manufacturers' Association.

Signed on behalf of the Operative Weavers,

T. Birtwistle,
Secretary of the North-East Lancashire Weavers' Association.

ADDENDA.

(12) Three or More Threads in One Dent.

When the number of lifts used are equal to the number of threads in a dent, the reed to be paid for shall be found as follows :—

For 3 threads in one dent add 25 per cent.
„ 4 „ „ „ 50 „
„ 5 „ „ „ 75 „
„ 6 „ „ „ 100 „

to the actual reed used, Stockport counts, 2 ends in one dent.

Example.—A 40 reed, or 20 dents per inch, 3 in each dent, shall be paid for as 50.

40 reed, 4 in a dent as 60
40 „ 5 „ „ 70 reed, and so on.

When the number of lifts used are not equal to the number of threads in each dent, the reed to be paid for shall be found as follows :—

For 3 ends in one dent add $37\frac{1}{2}$ per cent.
„ 4 „ „ „ 75 „
„ 5 „ „ „ $112\frac{1}{2}$ „
„ 6 „ „ „ 150 „

to the actual reed used, Stockport counts, 2 ends in one dent.

Example.—A 40 reed (20 dents per inch) 3 ends in each dent, as a 55 :—

the same reed with 4 in a dent as 70
„ „ 5 „ „ 85
„ „ 6 „ „ 100 reed, and so on.

Provided always that in no case shall a lower reed than 52 be paid for.

(13) One Thread in a Dent.

One thread in a dent shall be paid for as if the reed were half way between the actual number of threads per inch, and what it would be if there were 2 threads in a dent.

Example.—What is known as a 80 reed, 40 dents per inch, 1 thread in a dent, would be paid for as 60 reed.

(14) Mexicans.

Mexicans shall be paid by this list without any addition or deduction.

The foregoing addenda has been agreed to between the committees representing the employers and operatives, and the wording finally settled at a conference held on the 15th day of September 1891.

Signed on behalf of the Employers,

Joshua Rawlinson.

Signed on behalf of the Operative Weavers,

T. Birtwistle.

COLNE LIST.—PLAINS.—Table of Prices for One Pick, 100 yards of Warp.

Width of Cloth.	REEDS. Below 46.	Below 52 to 46.	Standard 52 to 64 (inclusive).	Above 64 to 70.	Above 70 to 72.	Above 72 to 74.	Above 74 to 76.	Above 76 to 78.	Above 78 to 80.
20 inches	1.8482	1.8673	1·9054	1.9435	1.9626	1.9816	2.0007	2.0197	2.0388
21 „	1.863	1.8822	1·9206	1.959	1.9782	1.9974	2.0166	2.0358	2.0551
22 „	1.8777	1.8971	1·9358	1.9745	1.9939	2.0132	2.0326	2.052	2.0713
23 „	1.8925	1.912	1·951	1.99	2.0095	2.0291	2.0486	2.0681	2.0876
24 „	1.9072	1.9269	1·9662	2.0055	2.0252	2.0449	2.0645	2.0842	2.1039
25 „	1.922	1.9418	1·9814	2.021	2.0409	2.0607	2.0805	2.1003	2.1201
26 „	1.9367	1.9567	1·9966	2.0366	2.0565	2.0765	2.0965	2.1164	2.1364
27 „	1.9515	1.9716	2·0118	2.0521	2.0722	2.0923	2.1124	2.1325	2.1527
28, 29, & 30 „	1.9662	1.9865	2·027	2.0676	2.0878	2.1081	2.1284	2.1486	2.1689
31 „	1.9859	2.0064	2·0473	2.0882	2.1087	2.1292	2.1497	2.1701	2.1906
32 „	2.0055	2.0262	2·0676	2.1089	2.1296	2.1503	2.1709	2.1916	2.2123
33 „	2.0252	2.0461	2·0878	2.1296	2.1505	2.1714	2.1922	2.2131	2.234
34 „	2.0449	2.0659	2·1081	2.1503	2.1714	2.1924	2.2135	2.2346	2.2557
35 „	2.0645	2.0858	2·1284	2.1709	2.1922	2.2135	2.2348	2.2561	2.2774
36 „	2.0842	2.1057	2·1486	2.1916	2.2131	2.2346	2.2561	2.2776	2.2991
37 „	2.1137	2.1355	2·1791	2.2226	2.2444	2.2662	2.288	2.3098	2.3316
38 „	2.1432	2.1653	2·2095	2.2536	2.2757	2.2978	2.3199	2.342	2.3641
39 „	2.1727	2.1951	2·2399	2.2847	2.3071	2.3295	2.3519	2.3743	2.3967
40 „	2.2022	2.2249	2·2703	2.3157	2.3384	2.3611	2.3838	2.4065	2.4292
41 „	2.2513	2.2745	2·3209	2.3674	2.3906	2.4138	2.437	2.4602	2.4834
42 „	2.3005	2.3242	2·3716	2.4191	2.4428	2.4665	2.4902	2.5139	2.5376
43 „	2.35	2.3739	2·4223	2.4707	2.495	2.5192	2.5434	2.5676	2.5919
44 „	2.3988	2.4235	2·473	2.5224	2.5472	2.5719	2.5966	2.6214	2.6461

COLNE LIST.—**CHECKS.—Table of Prices for One Pick, 100 yards of Warp.**

Width of Cloth.	REEDS. Below 46.	Below 52 to 46.	Standard 52 to 64 (inclusive).	Above 64 to 70.	Above 70 to 72.	Above 72 to 74.	Above 74 to 76.	Above 76 to 78.	Above 78 to 80.
20 inches	2.6051	2.632	2·6857	2.7394	2.7663	2.7931	2.82	2.8469	2.8737
21 „	2.6259	2.653	2·7071	2.7613	2.7884	2.8154	2.8425	2.8696	2.8966
22 „	2.6467	2.674	2·7286	2.7831	2.8104	2.8377	2.865	2.8923	2.9196
23 „	2.6675	2.695	2·75	2.805	2.8325	2.86	2.8875	2.915	2.9425
24 „	2.6883	2.716	2·7714	2.8269	2.8546	2.8823	2.91	2.9377	2.9654
25 „	2.7091	2.737	2·7929	2.8487	2.8766	2.9046	2.9325	2.9604	2.9884
26 „	2.7299	2.758	2·8143	2.8706	2.8987	2.9268	2.955	2.9831	3.0113
27 „	2.7506	2.779	2·8357	2.8924	2.9208	2.9491	2.9775	3.0059	3.0342
28, 29, & 30 „	2.7714	2.8	2·85714	2.9143	2.9429	2.9714	3.	3.0286	3.0571
31 „	2.7991	2.828	2·8857	2.9434	2.9723	3.0011	3.03	3.0589	3.0877
32 „	2.8269	2.856	2·9143	2.9726	3.0017	3.0309	3.06	3.0891	3.1183
33 „	2.8546	2.884	2·9429	3.0017	3.0311	3.0606	3.09	3.1194	3.1489
34 „	2.8823	2.912	2·9714	3.0309	3.0606	3.0903	3.12	3.1497	3.1794
35 „	2.91	2.94	3·	3.06	3.09	3.12	3.15	3.18	3.21
36 „	2.9377	2.968	3·0286	3.0891	3.1194	3.1497	3.18	3.2103	3.2406
37 „	2.9793	3.01	3·0714	3.1329	3.1636	3.1943	3.225	3.2557	3.2864
38 „	3.0209	3.052	3·1143	3.1766	3.2077	3.2389	3.27	3.3011	3.3323
39 „	3.0624	3.094	3·1571	3.2203	3.2519	3.2834	3.315	3.3466	3.3781
40 „	3.104	3.136	3·2	3.264	3.296	3.328	3.36	3.392	3.424
41 „	3.1733	3.206	3·2714	3.3369	3.3695	3.4023	3.435	3.4677	3.5004
42 „	3.2426	3.276	3·3429	3.4097	3.4431	3.4766	3.51	3.5434	3.5769
43 „	3.3119	3.346	3·4143	3.4826	3.5167	3.5509	3.585	3.6191	3.6533
44 „	3.3811	3.416	3·4857	3.5554	3.5903	3.6251	3.66	3.6949	3.7297

HEALD AND REED CALCULATIONS.

BEFORE being fully prepared to enter into the calculations regarding the weight of cloth, it is necessary to familiarise ourselves with some method of counting the ends of warp in the cloth. On the Manchester exchange the system adopted both for ends and picks is their number per quarter-inch; *e.g.*, a 16 by 14 means 16 ends per $\frac{1}{4}$-inch, or 14 picks per quarter. The methods used in the manufactory are based on the counts of reed. Formerly many systems of reed counts prevailed, each town or district having a method peculiar to itself; thus, Blackburn counts, Preston counts, and many others were at one time adhered to in their respective districts, but have now fallen into disuse, and almost been forgotten.

The Stockport counts are commonest in Lancashire, and based on the number of dents or splits of the reed in 2 inches, and as cloth is generally wrought two ends in a dent, this system is often taken as the number of ends in 1 inch. It is in use in almost every Lancashire manufacturing district, being adopted in consequence of its simplicity and suitability for calculation purposes.

The Bolton counts are still used in some mills in that town, and also in Bury and some few other districts. The system is based on the number of beers in $24\frac{1}{4}$ inches—a

beer comprising 20 dents. A Stockport 40's reed would have 485 dents on 24¼ inches, or 24¼ beers Bolton. A Bolton 24¼ reed is then equal to a Stockport 40's.

The Scotch systems are to take the number of dents or splits in the old Scotch ell, 37 inches, and in this system the splits per ell are expressed in hundreds; thus, 17°° indicates 1700 splits on 37 inches, almost equal to a 92 reed, Stockport; or, to take the number of porters on the same length. The Scotch porter is equal to the Lancashire beer—20 splits; thus, a 60 porter reed would equal 60 × 20 = 1200 splits or dents on 37 inches. A third method used in Scotland is the inch scale, which is the number of splits in 1 inch, and corresponding to the old Radcliffe and Pilkington method in Lancashire.

In the United States the inch scale is generally adopted.

In Scotland, as in Lancashire, the old complicated systems show a tendency to give way in favour of the simpler systems of counting the dents on 1 inch or on 2 inches, *i.e.*, the inch scale, or the Manchester and Stockport systems respectively. It will be greatly to the convenience of the textile trades when the British members of them adopt uniform methods of counting reeds, picks, yarns, &c.; and it seems probable that the Stockport system, once confined to a small district, will ultimately be *the* system of reed counting.

The obsolete systems of reed counting are:—

The **Blackburn** system, in which the counts referred to the number of beers of 20 dents each on 45 inches. The English ell was 45 inches.

The **Fustian** reed system of counting the number of beers of 38 ends or 19 dents on 24¼ inches—this modi-

fication of the Bolton count is even yet met with. The beer or porter of 19 dents is occasionally found in Scotland, and Yorkshire also.

The **Preston** systems, viz. :—

The $\frac{7}{8}$ count equalled the number of beers on 34 inches.
" $\frac{4}{4}$ " " " 39 "
" $\frac{9}{8}$ " " " 44 "
" $\frac{6}{4}$ " " " 54 "

The **Nankeen** count was the number of beers of 38 ends on 20 inches.

An old **Manchester** system was the number of beers on 36 inches.

A Summary of Reeds Counts now in use.

	1's reed in each system = the following dents in one inch.
Stockport—number of dents on 2 inches . . .	.5
Bolton—number of beers (each 20 dents) on $24\frac{1}{4}$ inches	.8247
Scotch ell—number of hundreds of splits or dents on 37 inches	2.7027
Scotch porter—number of porters (each 20 dents) on 37 inches	.5405
One inch scale—number of dents on 1 inch . .	1

To find an equivalent in any other system for a given counts in a given system.

Rule A.—*Multiply the given counts by the number of dents per inch in the standard of given system, and divide by the number of dents per inch in the standard of the required system.*

Case I.

Example.—To convert Bolton counts into inch scale counts, or, in other words, to find the number of splits per inch in a reed, having Bolton counts given, multiply those counts by .8247, and divide by 1. The answer shows the number of dents and decimal parts. 8.245 is more often taken, but it gives the number with less exactitude. The fraction is only taken to two places of decimals, showing thus the 100th parts of dents; *e.g.*, a 30 Bolton has $24\frac{74}{100}$ splits per inch ($.8247 \times 30 = 24.741$).

Case II.

Example.—To convert 30 Bolton into Stockport counts. Multiply 30 by .8247, and divide by .5.

Ans. Half-way between 49 and 50 on Stockport system.

Case III.

Example.—To convert 68 Stockport into Scotch.

$$68 \times .5 \div 2.7027 =$$

$$27027)340000(1258$$

27027
69730
54054
156760
135135
216250
216216
34

20)58(2 porters.
40
18 ends.

Ans. $12^{\circ\circ}$ and 58 over $= 12^{58}$, or 1200, 2 porters, and 18 ends.

Case IV.

Example.—To convert 40 porter reed into Stockport counts.

$$40 \times .54054 \div .5$$

$$\begin{array}{r} .54054 \\ \times \quad 40 \\ \hline .5)21.62160(43.24 \\ 20 \\ \hline 16 \\ 15 \\ \hline 121 \\ 10 \\ \hline 21 \end{array}$$

Ans. Slightly finer than a Stockport 43 reed.

To find ends in a given width, Bolton counts.

Rule B.—*Multiply counts of reed by* 1.649, *and by width in reed required.*

Example.—A cloth is required to be 38 inches wide (40 inches in reed), 60's Bolton counts.

$$60 \times 1.649 \times 40 = 3948 \text{ ends.}$$

Note.—1.649 is the calculated number of ends in 1 inch, calculating 2 ends in a dent—No. 1 Bolton counts.

Obtained thus—20 beers = 40 ends ÷ $24\frac{1}{4}$ inches.

$$\begin{array}{r} 2425)40000000(1.6494 \\ 2425 \\ \hline 15750 \\ 14550 \\ \hline 12000 \\ 9700 \\ \hline 23000 \\ 21825 \\ \hline 11750 \end{array}$$

In the reed table (XI.) given below, the first row of figures shows the proportion which these reeds bear to one another, and the lower rows indicate the fineness of

the different systems for 33 and 40 splits per inch respectively—the calculation results being given, which, however, might not frequently appear in practice—

Table XI.

The Inch Scale. Dents per inch.	Stockport Dents on 2 inches.	Bolton Beers on 24¼ inches.	Scotch. 100 dents on 37 inches.	Scotch Porter. Porters on 37 inches.
1	2	1.2125	0.37	1.85
33	66	40.	12.20	61
40	80	48.5	14.80	74

Reed for Striped Cloth.—In some striped fabrics, where the stripe is made by "cramping" the ends in the reed, they are at the same time worked with extra ends in each eye of the heald, to compensate for the extra ends in the dents of the heald, and thus the same counts of healds as reed are used. In other cases it is necessary to cramp the ends in the reed to form a stripe, when from the nature of the pattern they must be drafted in the ordinary way in the healds. In that case different counts of heald and reed will be used. In either case it is necessary to find the counts of reed required for a cloth in which the pattern is formed by condensing the ends in certain parts of the reed.

Rule C.—*Find the number of dents occupied in 2 inches of the cloth.*

Example.—What reed will be used for a cloth made by introducing a stripe of 30 ends 3 in a dent, 10 ends 2 in a dent, 60 ends 4 in a dent? When the cloth is woven 2 in a dent, the cumberboard is arranged for an 80 Stockport reed.

In a complete pattern there are 100 ends. These occupy 30 dents.

30	ends	3	in	a	dent.	.	.	10	dents.
10	„	2	„	.	.	.		5	„
60	„	4	„	.	.	.		15	„
								30	„

The cumberboard being arranged for an 80 reed will have 160 ends on 2 inches, therefore if 100 ends occupy 30 dents, 160 ends will require 48 dents; or, in other words, the reed will be a 48 reed Stockport counts.

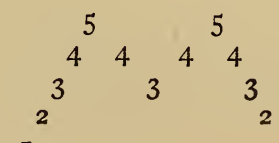
160
30
100)4800
Ans. 48

Healds.—In Stockport counts four healds are considered as a set, and four healds having one thread through each eye are dubbed of similar counts to the reed; *e.g.*, a 60's set of healds has 15 stitches per inch in each set, equalling 60 ends per inch in the reed, which is a 60's reed Stockport.

Spaced Healds.—In spaced healds some are knitted finer than others, and consequently numbered differently.

Rule D.—*To find the counts of each heald stave, with a broken draft, find the number of eyes per inch and multiply by* 4.

In this point draft:—



No. Heald.	No. Stitches on each.
5	2
4	4
3	3
2	2
1	1

twelve ends are drawn on five healds, one end on the 1st heald, two on the 2nd, three on the 3rd, four on the 4th, and two on the 5th. Four different degrees of fineness are required in the five heald staves, and the above draft is given to the knitter with instructions for so many patterns to the inch. Say five patterns per inch: 5 × 12 would give a 60 reed, and the number of stitches per inch would be respectively 5, 10, 15, 20, and 10—the front one being equal to a Stockport 20's, for if there were four similar to it in a set, the number of ends would be 20. Similarly, the second stave equals a Stockport 40's, the third 60's, the fourth 80's, and the fifth same as the second, a 40's. To prove this, the requisite set of five staves might be obtained by taking one stave out of a plain 20's set, two staves out of a plain 40's, one stave from a 60's, and one from an 80's set.

Healds are usually sold by the score of beers. A beer equals 40 ends in 20 dents, therefore a score equals 800 ends.

Reeds are sold by the beer of 20 dents each.

Reed Space and Width of Cloth.—The reed space of a loom is, as its name implies, a measurement of the size of the cavity which receives the reed, and is generally measured from the edge of the backboard to the edge of the fork-grate on the other side of the loom. We have to deal with the width of cloth obtainable from a given reed space. In the first place, some little width is lost in not being able to use the outside dents of the reed, in the thick dents, and in the loss of space at each end of the reed, probably on an average from these three causes three-quarters of an inch at each side, or an inch and a half in all. Then there is the contraction between the width of

the yarn in the reed and the width of the cloth on the counter, say 5 per cent. On 40 inch cloth this accounts for 2 inches more. On these premises we may assume that a 43 inch reed space loom might at the outside weave a 40 inch cloth, but in the list 39 inch cloth is considered to be the widest that can be conveniently woven, as the uniform list fixes the width at 4 inches from the reed space.

Much confusion has been caused by the principle of the old Blackburn list, which classed the width of looms by the width of cloth that was supposed to weave easily and not by the reed space, as for example a 45 inch reed space was generally called a 40 inch loom.

In the old Burnley list, on the contrary, the reed space was the width by which the loom was known. In addition to this, the figures cast on the loom were in many cases only nominal, and such anomalies as a 58 inch cloth being woven in a 55 inch reed space loom were not unknown. It is hoped that the explanation given will clear away many doubts, and that it will indicate why the new uniform list prohibits cloth from being woven within 4 inches of the reed space without an allowance.

Reeds to be Used.—The reeds to be used for the number of ends per inch vary accordingly as the cloth is required to be full, or poor, in the reed. The following table comprises two ranges actually in use for the two classes of cloth :—

Table XII.

Ends per Quarter Inch.	Reeds in Use for Poor Cloths.	Reeds in Use for Good Cloths.
8	28	29
10	35	36
12	41	43
13	45	47
14	49	51
15	52	54
16	56	58
17	60	62
18	64	66
19	68	70
20	70	72
22	78	80
24	86	88
26	92	96
28	98	102
30	104	110
32	112	118

The middle column is about 12½ per cent. less than the supposed number of ends per inch in the finished cloth, and the last column about 8 per cent. less. It will be noticed that each reed in the range is not proportional. This is a practical necessity, as a manufacturer usually desires as far as possible the numbers to descend in steps of four for the sake of convenience. This prevents mathematical accuracy. The words "full" and "good" cloths are used in a trade sense. Some makers of very good old-fashioned cloths use even finer reeds than those given.

STEAM-ENGINE CALCULATIONS.

THE motive-power of our mills is an interesting and important subject, and worthy of treatment in more space than we can devote to it in these pages. The millworker who takes an interest in his surroundings would find pleasure and useful information in the possession of one of the numerous handbooks treating of engines and boilers, the conversion of natural resources into heat, and the generation by means of that heat of the steam which drives our sheds and mills.

Specification of Engines and Boilers for Shed of 1000 Looms Plain Goods.

Engines.—Horizontal, high and low pressure, condensing. Indicated horse-power, 350.

Boilers.—Two Lancashire, working at 80 lb. pressure.

Economisers.—Set of 120 pipes.

The power of an engine is indicated in horse-powers. A horse-power is taken as the capacity of performing 33,000 foot-pounds of work in one minute; lifting 3300 lbs. 10 feet high, or 10 lbs. 3300 feet high would be 33,000 foot-pounds of work.

Parts of Steam-Engine.—The figure (6) will enable the reader to understand the allusions to various parts of the steam-engine. *PR* is the piston rod, with a hori-

zontal reciprocating movement; steam is admitted by the supply pipe *S*, either through the front port, *a*, or the back port, *c*, according to the direction in which the

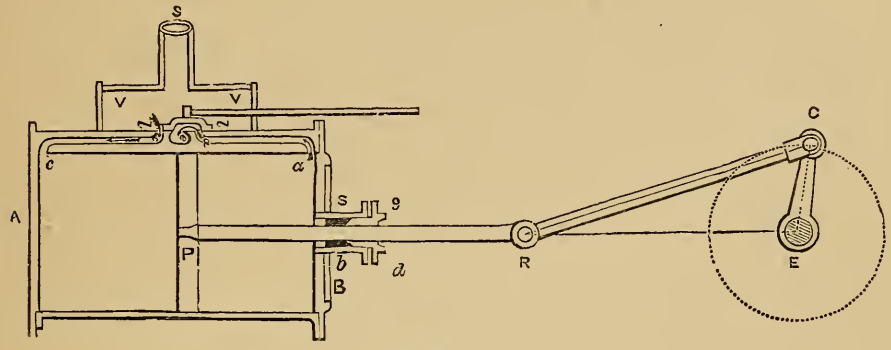


Fig. 6.

piston has to travel; the used steam escapes through the exhaust-port *e*. The slide-valve *l* on the slide-rod regulates the admission and exit of the steam.

To Obtain the Indicated Horse-power.—A diagram is taken from each end of each cylinder by means of a little piece of apparatus known as an indicator. This diagram shows the initial pressure of steam against the piston, and also the gradual lowering of pressure as the piston continues its stroke. An average is made at ten points of this steam pressure, and thus we obtain the average pressure throughout the stroke. This multiplied by the area of the piston gives the total pressure on the piston in pounds, and multiplied by the speed of the piston per minute in feet gives the number of foot-pounds of work done per minute.

Rule A.—*Multiply the average pressure of steam in the cylinder by the area of the piston, and by the speed of the*

piston, which is obtained by multiplying the length of stroke by 2, and by the number of strokes per minute. Divide the result by 33,000, which gives the indicated horse-power.

Example.—Find indicated horse-power from the following particulars:—Average pressure 39.81, area of piston 400 square inches, length of stroke $5\frac{1}{2}$ feet (equalling 11 feet both ways), strokes per minute 40.

```
                 39.81
                   400
              ---------
              15924.00
                   5½
              ---------
               79620
                7962
              ---------
               87582
                   2
              ---------
              175164
                  40
             ----------
33000)7006560(212.32 I.H.P.
      66000
      -----
       40656
       33000
       -----
        76560
        66000
        -----
        105600
         99000
         -----
          66000
          66000
          -----
```

Nominal Horse-power.—It is, in engineering establishments, customary to have a system of standardising the power of an engine apart from its speed and steam pressure.

Rule B.—*Divide the area of piston in inches by 22.*

Example.—What is the nominal horse-power of a single cylinder engine, piston 40 inch diameter?

$$
\begin{array}{r}
40 \times 40 = 1600 \\
.7854 \\
\hline
6400 \\
8000 \\
12800 \\
11200 \\
\hline
22)1256.6400(57.12 \text{ N.H.P.} \\
110 \\
\hline
156 \\
154 \\
\hline
2.64 \\
22 \\
\hline
44 \\
44
\end{array}
$$

Looms per Horse-power.—$2\frac{1}{2}$ to 3 looms, with preparation, are calculated to require 1 indicated horse-power.

Coal.—A good quality of coal should evaporate 8 lbs. of water for each 1 lb. burnt, and for a manufacturing concern (including sizing, which takes a great amount of steam) the consumption of coal should not be more than $3\frac{1}{4}$ lbs. per indicated horse-power per hour. Thus, 600 horse-power would use about 49 tons per week; excluding sizing, $2\frac{3}{4}$ lbs. would suffice.

To find the weight of coal used per indicated horse-power per hour.

Rule C.—*Reduce the weight used in a week to pounds, divide by the horse-power and by the number of hours run per week.*

Example.—Engines of 440 horse-power require 35 tons of coal per week. Engine running 56 hours.

$$\frac{35 \times 2240}{440 \times 56} = 3.18$$

Ans. 3.18 lbs. per I.H.P. per hour.

Safety-valves.—To find the pressure at which a valve will blow off.

Safety-valves are levers of the third order, and their use is to relieve the pressure of the boiler by opening when a certain pressure per square inch is arrived at.

Rule D.—*Multiply the weight in pounds by the distance of its point of suspension from the pin or fulcrum, and divide by the area of the valve and the distance from the fulcrum of its point of contact with the lever.*

Example.—A safety-valve lever is pivoted 3 inches from the top of the centre of the valve and 16 inches from the weight of 50 lbs. The diameter of the valve is 2 inches. At what pressure will it blow? The area of the valve is $2^2 \times .7854$.

$4 \times .7854 = 3.1416.$

$50 \times 16 = 800$

$3.1416 \times 3 = 9.4248.$

9.4248)800.0000(84.8 lbs. pressure.

753984.

460160

376992

831680

753894

77696

ARITHMETIC.

IN a book of textile calculations the necessity of introducing various mathematical rules is unavoidable, and in many cases the references to these rules may not be intelligible to some readers who are not so familiar with calculations as others, in consequence perhaps of lack of early education, or of practice in the use of figures. Thanks to the system of compulsory education, such are now few and far between; but the author considers that, in justice to these readers, he should make a few short explanations of the principal rules involved in this work, and of the signs and abbreviations adopted.

Signs and Abbreviations Used.

+ The sign of addition, signifies added to.
− ,, ,, subtraction, ,, from which is subtracted.
× ,, ,, multiplication, ,, multiplied by.
÷ ,, ,, division, ,, divided by.
= ,, ,, equality, ,, equal to.
$\sqrt{}$,, ,, the square root.
$\sqrt[3]{}$,, ,, ,, cube ,,
^{2} over a number signifies that that number has to be squared.
^{3} over a number signifies that it has to be cubed.
% stands for per cent.

The four fundamental rules of **Addition, Subtraction, Multiplication,** and **Division** are well known, and require no explanation excepting of the terms used in connection with them.

The **Sum** is the total of numbers added together.

The **Difference** or **Remainder** is obtained by subtracting one number from another.

The **Multiplicand** is the number which is multiplied by another.

The **Multiplier** is the number by which the multiplicand is multiplied.

The result of their multiplication is called the **Product.**

The number which is divided by another is called the **Dividend.**

The one by which it is divided is called the **Divisor.**

The result of the division is called the **Quotient.**

Proportion.—This is necessary to determine from a given ratio in which one number stands towards another number, what the ratio or proportion would be were the first number to be replaced by a third number; such as, for example, if a number of articles give a certain weight or length, or if a number of workmen do certain work, what would be the weight or length or work done if the original number of articles or men be changed?

Rule A.—*Place the three given numbers so that the two numbers in which the proportion is known stand first, and the third number is the one for which the proportion is unknown. To obtain the answer, multiply the second and third terms together, and divide by the first. The following signs are generally used:—*

: is to
: : so

Example.—If 7 skips of yarn contain 21000 cops, how many will 3 skips contain? The numbers are placed—

$$7 : 21000 :: 3 : \textit{ans.}$$

or as 7 is to 21000 so 3 is to the answer.

To obtain the answer, multiply the second and third terms together, and divide by the first.

$$21000 \times 3 = 63000$$

$$7)\underline{63000}$$

$$9000 \textit{ ans.}$$

Percentage may almost be classed with proportion, as it is really a proportion problem, 100 always being taken as the third term.

Percentage is the ratio which one number bears to another number, expressed in the ratio which 100 would bear to a certain number called the percentage.

Example.—A manufacturer calculates that he loses 2d. on a 75 yard piece which cost 16s. 8d., what is that per cent.?

Expressed in proportion terms—

$$200 : 2 :: 100 : \textit{ans.}$$

Multiply the second and third terms, and divide by the first.

$$2 \times 100 \div 200 = 1 \text{ per cent.}$$

Rule B.—*To find percentage, multiply the number of which it is desired to find the relation by* 100, *and divide by the term to which the other term bears relation.*

Example.—A man receives as dividend on shares £19. This bears relation to the value of his shares as 19 to 190, what is the percentage?

$$19 \times 100 \div 190 = 10 \text{ per cent. } \textit{ans.}$$

Vulgar Fractions.

A fraction is one or more parts of a thing, and indicates the number of parts.

It is written by two numbers, one above the other, with a line between, thus : $\frac{3}{7}$, $\frac{1}{2}$, $\frac{4}{9}$.

The lower number is called the **Denominator,** and shows the number of parts into which the thing is divided.

The **Numerator** is the upper number, and shows how many of these parts are represented, as $\frac{7}{8}$ = seven-eighths, $\frac{4}{7}$ = four-sevenths.

Reducing.—To reduce fractions to their lowest terms. **Cancelling** is another name for this.

Rule C.—*Find a number that will divide into both the numerator and denominator without remainder, and divide them until they are no longer both divisible by a number greater than one.*

The value of the fraction will not be altered. Thus $\frac{75}{100}$ may be divided by 5, and gives $\frac{15}{20}$. This is again divisible by 5, and is reduced to $\frac{3}{4}$.

To Add Fractions.

Rule D.—*Reduce them to a common denominator, and add the numerators.*

Thus: $\frac{1}{2} + \frac{4}{7} + \frac{3}{10}$.

Seventy is the lowest number which will contain 2, 7 and 10 without remainder, and the three fractions are then described $\frac{35}{70}$, $\frac{40}{70}$, $\frac{21}{70} = \frac{96}{70}$.

This may be reduced by dividing by 2 to $\frac{48}{35}$ or $1\frac{13}{35}$ *ans.*

To Subtract Fractions.—Proceed as in addition, but subtract the smaller numerator instead of adding.

To Multiply Fractions.

Rule E.—*Multiply all the numerators together for a numerator, and all the denominators together for a denominator.*

Example.—Multiply $\frac{3}{4}$, $\frac{5}{6}$, $\frac{7}{8}$ together.

$$3 \times 5 \times 7 = 105$$
$$4 \times 6 \times 8 = 192$$

This may be reduced, by dividing by 3, to $\frac{35}{64}$ *ans.*

Division.—To divide fractions.

Rule F.—*Invert the divisor and multiply.*

Example.—

$$\frac{49}{80} \div \frac{7}{8} = \frac{49}{80} \times \frac{8}{7} = \frac{392}{560}$$

This may be reduced by dividing by 56 to $\frac{7}{10}$ *ans.*

Decimal Fractions are expressed always in tenths, hundreds, thousands, &c.; and the numerator only is written. A **point** is placed before the decimal number to distinguish it from an ordinary one, and to the right of the point the tenths are placed, or, if none, a cypher; then the hundreds are placed as the second figure from the point, thirdly, the thousandth. Thus $\frac{1}{10}$, $\frac{6}{100}$, $\frac{3}{1000}$ would be written .163, or .796 would be $\frac{796}{1000}$ or $\frac{7}{10}$, $\frac{9}{100}$, and $\frac{6}{1000}$.

Decimals are far more suitable to textile calculations than vulgar fractions, and their use should be cultivated by the earnest student.

The **addition** and **subtraction** of **decimals** is proceeded with as in ordinary figures, care being taken to get the points exactly under one another.

Rule G.—Multiplication.—*Multiply the two numbers together irrespective of the decimal points, and afterwards count from the right of the product as many figures as*

there were to the right of the multiplier and multiplicand, and place the point.

Example.—

1.347 × 2.86

$$\begin{array}{r} 1.347 \\ 2.86 \\ \hline 8082 \\ 10776 \\ 2694 \\ \hline 385242 \end{array}$$

There are three figures to the right of the point in the multiplicand, and two in the multiplier. The point is therefore placed as under, five figures from the right—

3.85242

Recurring Decimals.—Certain fractions cannot be expressed in full in the decimal system, *e.g.*, $\frac{1}{9}$ in decimals would be .111111111, and so on.

These are called recurring or repeating decimals, and are marked by placing a point over them, or if there are several in the repeat, over the first and last of the group.

Example.—

$\frac{1}{9}$ is written $.\dot{1}$

$\frac{1}{7}$ is written $.\dot{1}42857\dot{}$

Square Root.—To extract.

This problem, known as one branch of evolution, consists in finding the number which, when multiplied by itself, or, in other words, when squared, gives, as the product, the given number.

Rule H.—*Divide the number into pairs of figures, beginning at the unit place. Find the greatest number which, when multiplied by itself, i.e., when squared, will be con-*

tained in the left-hand figure or pair; place this root as a quotient, and as a divisor also, and subtract their product as in ordinary division. Then bring down two more figures, and double the previous divisor, and add the largest figure to it that can be the quotient also. Then multiply the divisor by this figure. Double the quotient, and proceed as before. If there is a remainder, add two cyphers to it, and proceed as before, calling each addition to the quotient a decimal.

Example.—Find square root of 8462548064.

Mark off thus. 9 is the root of the greatest square contained in 84.
Double 9. 1 is the highest number that can be added to 18 and to the quotient 9.
Double 91.
Add 2 cyphers and place a decimal point to the quotient.

```
 9)8462548084(91992.1
   81
181)362
    181
1829)18154
     16461
18389)169380
      165501
183982)387984
       367964
1839841)2002000
        1839841
         162159
```

Ans.—91992.1.

In all textile calculations the slide rule will be found very useful, and is well worthy of study by the earnest textilist. The old-fashioned, antiquated rule is not referred to, but the modern one, constructed on the lines of the rules largely used by many Continental manufacturers. A book by Mr. J. W. Nasmith, of Mulhouse, Alsace, shortly to be published by Mr. John Heywood, will treat exhaustively of this subject.

EXAMINATION QUESTIONS AND ANSWERS.

HE City and Guilds of London Institute hold annually an excellent series of examinations in the different trades. For some years cotton-weaving was examined with cotton-spinning under the name of "Cotton Manufacture," while questions were concurrently given under the subject of "Weaving and Pattern Designing," which included also woollen, worsted, silk, jute, and linen weaving. In 1889, for the first time, a separate examination was held in "Cotton-Weaving."

The author, considering that it would be beneficial to the textile student of our technical schools to reprint some of these questions and append answers, and that it would also be interesting and instructive to older readers to study the various exercises that have been propounded, has here given a selection from the various papers.

Questions necessitating calculations have alone been given, and questions referring to other textile trades have been omitted, as have also duplicate or similar questions given in different years.

As most calculation questions are repeated in succeeding years, the duplicates not answered in this book are left for test questions, to be given by the teachers.

Selections from Weaving and Designing Papers.

1883.—No. 5.—If you are weaving a 7 pick pattern with tappets (that is, a pattern which recurs every seven picks), and your tappet-wheel contains 150 teeth, whilst the wheel on the crank shaft contains 25 teeth, how will you obtain the proper rate of speed for the tappets, and what wheels will you use for the purpose ?

Intermediate wheels would be required.

By rule given on page 88 it is shown that we must find what proportionate speed the 25 and 150 would give; $150 \div 25 = 6$. Then as 6 is to 7 so are the two intermediate wheels to one another, say 60 and 70. The train of wheels would be 25 driving 70, and 60 driving 150.

No. 11.—Calculate the cost of material in a piece of cloth made as follows:—100 ends per inch of twofold 70's cotton at 2s. 3d. per lb., 84 picks per inch of single 40's worsted at 2s. 5d. per lb. The piece to be woven 30 inches in the reed, 53 yards long, made from 58 yards of warp, allowing 5 per cent. for weft wasted in weaving.

Rules given on pages 14 and 20.

$$30 \times 100 \times 58 \div 840 \times 35\text{'s} = 5.91 \text{ lbs. twist.}$$
$$30 \times 84 \times 53 \div 560 \times 40\text{'s} = 5.962$$
$$\text{Add } 5\,\% = \underline{.298}$$
$$6.26$$

5.91 lbs. twist at 2*s.* 3*d.* = 159.57*d.*
6.26 „ weft „ 2*s.* 5*d.* = 181.54*d.*
341 = £1, 8*s.* 5*d.*

1884.—Ordinary Grade.—No. 5.—A drum 13 inches in diameter, making 120 revolutions a minute, is required

to give motion to a shaft required to make 156 revolutions. Find the diameter of the pulley required.

Rule given on page 62.

Ans. $120 \times 13 \div 156 = 10$ inches.

No. 9.—How many hanks will be in a pound weight of two-ply yarn made by twisting one thread of 24's and one of 30's single cotton yarn together?

See Rule on page 46.

Ans. Multiply 24×30, and divide by $24 + 30 = 54$.

$$
\begin{array}{r}
24 \\
30 \\
\hline
54)720(13.3 \\
54 \\
\hline
180 \\
162 \\
\hline
18
\end{array}
$$

Ans. $13\frac{1}{3}$'s.

No. 10.—Having 40's cotton yarn, and wishing to twist it with another yarn to make it 24's, what numbers would you employ?

Ans. By rule E. on page 46.

$$
\begin{array}{l}
40 \times 24 = 960 \\
40 - 24 = \ 16 \\
\qquad 16)960(60\text{'s} \\
\qquad\quad 96
\end{array}
$$

Ans. 60's.

No. 13.—Give a calculation showing the weights of warp and weft in a piece of cotton cloth woven in a 20-reed with eighteen shots (Manchester count), 40 inches wide, 60 yards, 70's warp, 80's weft. Allow what you consider

necessary for shrinkage in length and width, and extra ends for selvages.

Rules given on pages 14 and 20.

Width to be taken at 40, with say 2 inches allowed for contraction and selvages.

20 reed × 18 shots = 80 × 72 to the inch. Allow 3 per cent. on length.

Twist . $42 \times 80 \times 61\frac{3}{4} \div 840 \times 70 = \underline{3.53 \text{ lbs.}}$

Weft . $42 \times 72 \times 60 \div 840 \times 80 = \underline{2.7 \text{ lbs.}}$

1885.—Ordinary Grade.—No. 10.—Explain the counts or Nos. by which the fineness of cotton, silk, linen, woollen, and worsted yarns are indicated. How would you proceed to prove the counts of any yarn?

Explanation of this is given on pages 39 to 53.

1886.—Ordinary Grade.—No. 6.—If the crank shaft of a loom is making 130 revolutions a minute, having a 12-inch pulley, what size of pulley will you require to have on to make it revolve at the rate of 160 revolutions a minute?

Rule given on page 63.

A smaller pulley would be required.

$130 \times 12 \div 160 =$

$$160)1560(9\tfrac{3}{4}$$
$$\underline{1440}$$
$$\frac{120}{160} = \tfrac{3}{4}$$

Ans. $9\frac{3}{4}$ inches.

1886.—Honours Grade.—No. 1.—It is required to weave a piece of cloth which must be 48 yards long and 28 inches wide, and you have only 180 hanks of weft

yarn (cotton). How many picks per inch must the piece contain?

No rule has been given for this, but the reader can easily deduce one from the abundant explanations given in the early part of the book.

Rule A.—*Multiply width by length, and divide into length of yarn given.*

$$48 \text{ yards} \times 28 = 1344. \qquad 180 \times 840 = \underline{151200}.$$

$$151200 \div 1344 = \underline{112\tfrac{1}{2}}.$$

Ans. $112\frac{1}{2}$.

No. 10.—How many hanks will be contained in one pound weight of 3-fold yarn made by twisting one thread of 10's, one of 30's, and one of 50's single worsted yarn together?

Rule given for finding counts on page 47.

$$50 \div 50 = 1$$
$$50 \div 30 = 1.66$$
$$50 \div 10 = \underline{5}$$
$$7.66$$

$$\begin{array}{r} 7.66)5000(6.52 \text{ hanks in a pound} \\ \underline{4596} \qquad \text{of the 3-fold yarn.} \\ 4040 \\ \underline{3830} \\ 2100 \end{array}$$

1887.—Ordinary Grade.—No. 2.—What will be the resulting counts of two threads twisted together as follows—viz., 80's single cotton with 32's single worsted? And what quantity of each will be required to produce 100 lbs. of folded yarn?

First find equivalent in worsted of 80's cotton.
Rules given on pages 50 and 46.

$$80 \times 840 \div 560 = 120\text{'s}$$
Twofold 32's and 120's =
$$32 \times 120 \div 32 + 120 =$$
$$3840 \div 152 =$$

25.26's counts of resultant yarn expressed in hanks of 560 yards.

100 lbs. × 25.26 = 2526 hanks of each.

32)2526(78.94 lbs. of worsted.
224
286
256
300
288
120

25.26 hanks of 560 yards × 100 × 560 ÷ 840 = 1684 hanks of 840 yards.

80's)1684(21.05 lbs. cotton.
160
84
80
4

Ans. 25.26's; 78.94 lbs. worsted; 21.05 lbs. cotton.

No. 10.—What is the speed of a loom driven by a 14-inch drum on main shaft, making 120 revolutions per minute; loom pulley being 10½ inches?

Rule given on page 59.

120 multiplied by 14 and divided by 10½.

Ans. 160 picks per minute.

No. 11.—What number of shots, per inch, will a 30-teeth change pinion give, other parts of the motion being

—ratchet wheel, 50 teeth; intermediate wheel, 120 teeth; and intermediate pinion, 15 teeth; feed roller wheel, 75 teeth; and circumference of feed roller, 15 inches?

Ans. Rule given on page 92.

$$50 \times 120 \times 75 \div 15 \times 15 = 2000.$$

$$\begin{array}{rl} & 2000 \\ 1\tfrac{1}{2} \text{ per cent.} = & \underline{30} \\ 30) & 2030(67\tfrac{2}{3} \\ & \underline{180} \\ & 230 \\ & \underline{210} \\ & 20 \\ & 30 \end{array}$$

Ans. $67\frac{2}{3}$ picks per inch.

No. 12.—State the time it will take a loom to weave 60 yards of cloth with 80 shots per inch. Diameter of pulley on crank shaft 8 inches; diameter of drum on main shaft, 14 inches; main shaft revolutions, 120 per minute, allowing 20 per cent. for stoppages.

The piece has $60 \times 36 \times 80 = 172800$ picks in it.

The loom makes per minute—

$$\begin{array}{rr} 120 \times 14 \div 8 = & 210 \\ \text{Less 20 per cent.} & \underline{42} \\ & \underline{168} \text{ picks.} \end{array}$$

$172800 \div 168 = 1028\frac{4}{7}$ minutes $= 17$ hours $8\frac{4}{7}$ minutes.

Ans. 17 hours, $8\frac{4}{7}$ minutes.

1888.—Ordinary Grade.—No. 13.—Make a stripe as follows:—60 ends cotton, 40 ends silk, 24 ends cotton, 20 ends silk. Cotton 2 ends in a split, silk 4 in a split. Reed 40 splits or dents per inch, width of piece 32 inches in reed. How many ends of each material will be required?

Ans.

60 ends of cotton at 2 ends in a split occupy = 30 splits.
40 ,, silk ,, 4 ,, ,, = 10 ,,
24 ,, cotton ,, 2 ,, ,, = 12 ,,
20 ,, silk ,, 4 ,, ,, = 5 ,,
One stripe occupies = 57 ,,

Number of splits available = 40 × 32 = 1280

57)1280(22 complete stripes and 26 splits over
114
140
114
26

The 26 splits could be used for a border of cotton 2 ends in a split, thus giving a cotton border at each side of the piece, and the number of ends of cotton that would be then required would be—

22 stripes each 84 ends cotton = 1848
26 splits ,, 2 ,, ,, = 52
1900 ends cotton.
22 stripes each 60 ends silk = 1320 ,, silk.

Honours Grade.—No. 1.—*Same paper.*—Give the average counts of yarn in any cloth composed of alternate threads of single 16's and single 40's yarn.

Ans. Apply rule given for twofold yarn, page 46, and multiply by 2.

16 × 40 ÷ 16 + 40
56)640(11.428
56
80
56
240
224
160
112
480

11.428
2
22.856's *ans.*

Proof:—

1 hank of 16's	weighs	$437\frac{1}{2}$	grains
$\frac{1}{2}$ „ 40's	„	175	„
$\frac{1}{2}$ hanks	„	$612\frac{1}{2}$	„
Average = 1 hank	„	$306\frac{1}{4}$	„

$7000 \div 306\frac{1}{4} = 22.856$'s

Ans. 22.856's.

Selections from the Cotton Weaving[1] Examination Questions.

1889 Examination.—Ordinary Grade.—No. 7.—How many tokens of 20 healds each will you have on each heald in a five-end satin with a total of 1600 ends? And what space will each token stand in, suppose the healds are for a 50-reed Manchester counts of reed?

Ans. 1600 ends in all ÷ 5 shafts = 320 on each shaft, making no allowance for plain selvage.

$$\frac{320}{20} = 16 \text{ tokens on each heald or shaft.}$$

The whole reed space occupied is $1600 \div 50 = 32$ inches.
Each token therefore stands in $32 \div 16 = 2$ inches, or, in other words, there are 20 eyes in every 2 inches of each shaft.

No. 13.—What pinion or crank shaft and intermediate or carrier wheels would you use to drive a woodcroft tappet 16 picks to the round, if the tappet wheel has 180 teeth?

[1] Cotton Weaving. The subjects which are comprised in the syllabus to be studied for this examination in addition to the calculations, such as the construction and use of the machinery, both in the weaving and preparatory processes, are fully described in the author's book on "Cotton Manufacturing," price 6s.

Ans. One wheel on crank shaft would not drive 180 at the required speed, as $180 \div 16$ gives a broken size.

A pair of intermediate wheels must be employed. Apply rule on page 88. Supposing any wheel, say 16, to be on the crank shaft—

$$\frac{180}{16} = 11\tfrac{1}{4}$$

As $11\frac{1}{4}$ is to 16 so the required wheels are to another, say 45 and 64.

The train would be 16 driving 64
„ „ 45 „ 180

No. 14.—What change wheel will you require to put in 25 picks per quarter inch? The ratchet wheel has 120 teeth driving the required pinion, which gears into a carrier wheel of 50 teeth, and 30 teeth driving the roller wheel of 90 teeth, the roller being 15 inches in circumference.

Apply Rule D. on page 92 for obtaining dividend.

$$\frac{120 \times 50 \times 90}{30 \times 60} = 300$$

60 is the circumference of roller in quarter inches.

Add $1\frac{1}{2}$ per cent. for contraction, 300
$4\frac{1}{2}$
$304\frac{1}{2}$

$304\frac{1}{2} \div$ picks required, $25 = 12.18$

Ans. Nearest change wheel 12, which, being less size than calculation gives, would give more than 25 picks to the $\frac{1}{4}$ inch (about $25\frac{3}{8}$).

No. 18.—You have 160 bobbins of 30's twist, each containing 8 ozs. of yarn, and wishing to use all the yarn (allowing 5 per cent. for material left on the bobbins and waste) in a warp of 3600 ends, what length should the warp be?

Multiply 30's by 840 to find yards in a pound, and divide by 2 to get length in half a pound, deduct 5 per cent.—

Giving 11970 yards usable on each bobbin.

11970 × 160 bobbins = 1915200 total yards usable, and this divided by 3600 gives length of warp.

Ans. 532 yards.

No 19.—A piece of cloth, 40 yards long, 30 inches wide, with 80 ends per inch (out of loom), and 120 picks per inch, contains 18 lbs. of yarn; what is the average counts of warp and weft, allowing a shrinkage of 10 per cent. from reed?

Ans. Apply Rule L., page 28.

The width = 30 + 10 per cent. = 30 + 3 = 33. The tape length will be about 42 yards. The length of twist =

33 × 80 × 42 yards = 110880.

The length of weft is—

33 × 40 × 120 = 158400.

110880 + 158400 = 269280 yards.

269280 divided by 840 and by 18 lbs. gives 17.809.

Ans. 17.809's average counts.

Honours Grade.—No. 4.—*Same paper.*—If you are placing a loom to run 180 picks per minute side by side with a loom to run 96 picks per minute, in a shed where the shaft makes 108 revolutions, what size of drum would you put on the shaft, and what size of pulley on the loom in each case?

Ans. The proportionate sizes of driving and driven pulleys in the first case will be 180 to 108, or, say, 15 inches driving and 9 inches driven.

In the second case 96 to 108, or, say, 16 and 18 inches respectively.

No. 15.—Suppose you are weaving a plain cloth with 60 ends per inch and 60 picks per inch, equal counts of warp and weft, and you wish to make a four-end twill using the same yarns, how many ends and picks per inch would you put in to make a cloth of similar firmness?

Ans. Suppose the 4-end twill to be an ordinary one—2 ends up out of 4. There would be two intersections in 4 ends, that is, 4 ends and 2 picks passing through equal to 6 threads.

In 4 ends of plain there are 4 intersections, 4 ends, and 4 picks, equals 8 threads. Then with the same reed and pick and yarns the twill would be looser, or to make it as firm we must increase it at the proportion of 6 to 8, or—

$$\frac{60 \times 8}{6} = 80 \text{ ends} \times 80 \text{ picks per inch.}$$

No. 16.—Calculate the cost of 1 dozen tapestry table-covers from the following particulars:—Size on table 32 × 34 inches, 33 inches in reed.

		s.	*d.*	
Warps 600 ends 2/60 indigo blue at		3	2	per lb.
,, 2,432 ends 2/40 red . .	,,	1	4½	,,
,, 2,432 ends 2/40 brown .	,,	1	4½	,,
Weft 30 picks per inch 6's ecru	,,	1	1	,,
,, 30 ,, ,, 6's black	,,	1	1	,,

Weaving, 1s. 3d. per dozen; general expenses, 20 per cent. more than weaving; allow 5 per cent. for waste in both warp and weft, 5 per cent. for the taking up of the coarse warps in weaving, and 10 per cent. for the taking up of the fine warp.

Ans. Weight of 2/60's.

Length = 34 inches × 12 + 10 per cent. for length.

$34 \times 12 = \underline{408}$.

408
40.8
448.8 inches
600 ends
36)269280.0
7480 yards

7480 + 5 per cent. waste.

374
840)7854(9.35
7560
2940
2520
4200
4200

2/60's or 30)9.35(.311 lbs.
90
35
30
50

.311 at 3*s.* 2*d.* = 11.8*d.*

Weight of 2/40's.

Length 34 × 12 = 408 + 5 per cent. = 428.4.

428.4
4864 ends
17136
25704
34272
17136
36)20837376(578811½ yards.
180
283
252
317
288
293
288
57
36
21

2894 5 per cent. waste
840)60775½(72.35 hanks
5880
1975
1680
295.5
252.0
43.50

20)72.35(3.61 lbs.
60
123
120
35

3.61 lbs. at 1*s.* 4½*d.* = 59.56*d.*

Weft—

$$33 \times 60 \text{ picks} \times 11\tfrac{1}{3} \text{ yards} \div 6\text{'s} \times 840 = 4.45 \text{ lbs.}$$

4·45
.22 = 5 per cent. waste.
4.67 at 1*s.* 1*d.* 60.71*d.*

	d.
Twist	11.8
	59.56
Weft	60.71
Weaving	15.00
Exs. = $1\frac{1}{5}$ weaving . .	15.00
	3.00
	165.07 per doz. = 13*s.* 9*d.*

Ans. 13*s.* 9*d.* per dozen.

1890 Paper.—Ordinary Grade.—No. 3.—What is the counts of a doubled thread composed of 20's and 40's twisted together?

Apply Rule D. and Example, page 46.

Ans. 13.33's.

No. 4.—How much 60's twist will you require for a set of slasher's beams, the whole set to contain 2360 ends, 18000 yards?

Apply Rule D., page 72. Multiply 2360 by 18000, and divide by 840 to bring it to hanks, and then by 60, the counts.

$$\frac{2360 \times 18000}{840 \times 60}$$

Ans. 842.85 lbs.

No. 9.—If weaving 8-end satin, 40 inches in reed, 56 reed, Stockport counts, how many healds would you require on each stave in two inches. Also, how many

healds for each stave, if drawn in on 8 staves, centred backwards and forwards, if for a 14-end pattern?

In the case of an 8-end satin there would be an equal number of ends on each stave (see draft, Fig. 7). There would be 8 healds. In two inches of 56 reed Stockport, two ends in a dent, there would be 112 ends. This divided by the number of staves (8) gives the number of heald eyes on each stave—namely, 14.

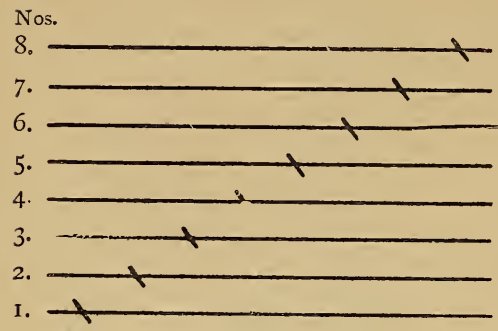


Fig. 7.

Ans. 14.

The second part of the question involves a different draft, shown at Fig. 8. It will be seen that the first stave

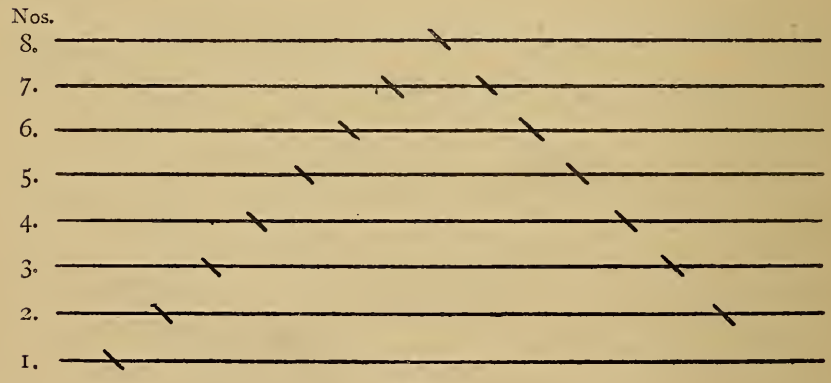


Fig. 8.

and the eighth have only half as many ends or eyes on them as the others. A glance at the draft shows that out

of 14 ends 2 healds have 1 end each, and 6 healds 2 ends each.

Apply Rule B.

Rule B.—*Having given the counts of reed, the number of healds required for the pattern, and the number of ends on each stave for one pattern, the number of ends on each stave for any distance can be found by dividing the total number of ends for that distance by the number of ends in the pattern, and multiplying by the number of ends on each stave in one pattern.*

As there are 14 ends in the pattern and 112 ends in 2 inches, there are $\frac{112}{14} = 8$ patterns.

Multiplying this by the ends on each stave in one pattern, we have the ends on each stave in 2 inches.

1st stave . .	$8 \times 1 = 8$
2nd ,, . .	$8 \times 2 = 16$
3rd ,, . .	$8 \times 2 = 16$
4th ,, . .	$8 \times 2 = 16$
5th ,, . .	$8 \times 2 = 16$
6th ,, . .	$8 \times 2 = 16$
7th ,, . .	$8 \times 2 = 16$
8th ,, . .	$8 \times 1 = 8$
	112

No. 14.—What size of pulley will you require on a loom to give 168 picks per minute, if the driving drum is 14 inches on a shaft running 108 revolutions?

See Rule D., page 62.

Multiply 14 by 108 and divide by 168. The answer is 9 inches diameter of pulley required.

No. 15.—Draw the taking-up motion you are accustomed to, and give the train of wheels required to weave

112 picks in 1 inch of cloth; circumference of taking-up roller 14 inches.

For sketch of taking-up motion, see page 91. This is adapted to lower picks than the question refers to, but still the necessary picks could be inserted. As explained on page 92, find the dividend for that particular gear by applying Rule D. Taking the same wheels as are given on the page mentioned, with a 14-inch cloth roller, the dividend is $50 \times 75 \times 100 \div 12 \times 56 = 558.03$, add $1\frac{1}{2}$ per cent. $= 586.4$. This, divided by the number of picks to the quarter, 28, gives a change wheel of 20.4 teeth. Either a 20 or a 21 would be used, say a 20. The complete train in this case would be 50, 20, 100, 12, 75, and 14 inch cloth roller. The wheel 20 gives rather more than the desired picks, but is the nearest that can be used with the taking-up motion under discussion. A Pickles' motion, page 93, would give the exact result with either 84 and 27 or 56 and 18 change wheels.

Honours Grade.—No. 11.—*Same paper.*

What is the value per yard grey of the following quilting cloth (show all calculations), 72 reed Stockport counts, 31 inches in the reed:—

Face warp 2 ends in dent 60's twist 1.25 yards of warp per yard of cloth.

Back warp 1 end in dent 32's twist 1.1 yards of warp per yard of cloth.

Total picks 180 per inch, in the order of 10 picks of face weft 50's to 2 picks of back weft 12's.

Weaving $2\frac{1}{4}$d. and general expenses $2\frac{1}{2}$d. per yard.

Prices of yarn in loom, 60's 16d., 32's $14\frac{1}{2}$d., 50's weft $13\frac{1}{2}$d., 12's weft $9\frac{3}{4}$d.

This calculation must be treated as if there are two

separate cloths. One cloth is made 31 inches, 72 reed, 1 yard long, 2 ends in each dent, 60's twist, and with $\frac{10}{12}$ of the total picks per inch, 50's weft. The other cloth is 31 inches, 72 reed, 1 yard, 1 end in a dent, 32's twist, and with $\frac{2}{12}$ of the total picks per inch of 12's weft. The contraction allowances are given, and no allowance is made for side ends, as explained in the chapter relating to cloth calculations, nor is any special allowance made for waste, as the prices given in the question cover cost of yarn *in* the loom.

Take the first cloth, applying Rules A. and B. on page 10.

$$\frac{31 \times 72 \times 1.25}{840 \times 60\text{'s}} = .0553 \text{ @ } 16d. \text{ per lb.} = \underline{.8848d.}$$

Weft.—Apply Rule D., on page 20. $\frac{10}{12}$ of the picks belong to this cloth, and are of 50's weft.

$$\frac{180 \times 10}{12} = 150 \text{ picks per inch.}$$

$$\frac{31 \times 150 \times 1}{840 \times 50} = .1107. \quad .1107 \text{ @ } 13\tfrac{1}{2}d. \text{ per lb.} = \underline{1.494} \text{ pence.}$$

Second cloth.—Warp, see same rule as for the other warp. As there is only 1 end in a dent, there will only be 36 ends per inch.

$$\frac{31 \times 36 \times 1.1}{840 \times 32} = .0456 \text{ lbs. @ } 14\tfrac{1}{2}d. = \underline{.6612d.}$$

Weft.—See same rule as for other weft. The picks are $\frac{2}{12}$ of the whole 180 or 30 per inch.

$$\frac{31 \times 30 \times 1}{840 \times 12} = .0922 \text{ lbs. @ } 9\tfrac{3}{4}d. = \underline{899d.}$$

Summary:—

	d.
1st cloth, twist	.8848
weft	1.494
2nd „ twist	.6612
weft	.899
Weaving per yard . . .	2.25
Other expenses per yard . .	2.5
Ans. Grey cost per yard . . .	8.689 pence.

No. 12.—An engine is driving a line shaft by ropes, and running 60 strokes per minute, with a driving drum of 20 feet. Give a size for line shaft drum to be driven by engine drum, and speed of line shaft; also, presuming you have mitre wheels on driving shafts of shed from line shaft, give sizes of drum driving loom, and loom pulley to drive your loom 180 picks per minute.

Three wheels have to be found,—the driven one on the line shaft, the drum driving the loom, and the pulley on the loom. Some liberty is left to the candidate in assuming the dimensions of the pulleys. Suppose the ratio of the dimensions of the driving drum and the loom pulley is 15 to 10. This would give a firm grip and good driving. Then the speed of the shaft over the looms would be 120; for 180 multiplied by 10 and divided by 15 equals 120. Here the Rule C. given on page 61 has been applied. 120 is the speed both of the shaft over the looms and the line shaft, as mitre wheels connect them. The drum driving the line shaft is 20 feet diameter, running 60 revolutions per minute. Then applying Rule D. on page 62, the pulley on the line shaft must be—

$$\frac{60 \times 20}{120} = 10 \text{ feet diameter.}$$

Ans. The whole train would thus be 20 feet drum, speed 60 revolutions per minute, driving 10 feet pulley on the line shaft; on same shaft is mitre wheel, say 50, geared with another 50 mitre wheel on shaft over looms, carrying a 15 inch pulley driving a 10 inch pulley on the loom.

The proof of the accuracy of this train can be found by applying Rule A., page 59, thus—

$$\frac{60 \times 20 \times 50 \times 15}{10 \times 50 \times 10} = 180 \text{ revolutions of loom pulley per min.}$$

1891.—Ordinary Grade.—No. 3.—Referring to the process of beaming a ball warp, give the number of teeth per inch in the wraithe if the warp contains 84 beers by 20, and stands 28 inches between the flanges.

If the warp contains 84 beers of 20 ends each, there will be 84 × 20, or 1680 ends in all. Divide this by the space occupied between the flanges of the beam, viz., 28 inches, and we have the ends per inch = 60. There would probably be for this size of warp 4 ends in the dent of the wraithe, then there must be 15 teeth per inch; if 2 ends per dent, then 30 dents per inch; if 6 ends per dent, then 10 dents per inch, &c.

No. 5.—What weight of yarn shall I dye of each colour to make a pattern warp, 2 blue, 2 yellow, 2 blue, 6 red, 2 blue, 2 yellow, 2 blue? The warp to contain 720 ends of 20's twist, and to be 820 yards long. 5 per cent. allowed for waste.

Apply Rule A. and Rule H., pages 14 and 25.

720 ends × 820 yards ÷ 840 and 20's = 35.143 lbs.
Add 5 per cent. 1.757 „
36.9 lbs.

The ends in one pattern are 18, of which 8 are blue, 4 yellow, and 6 red.

$\frac{8}{18}$ of 36.9 lbs. are $8 \times 2.05 = 16.2$ blue.
$\frac{4}{18}$ „ 36.9 „ $8 \times 2.05 = 8.1$ yellow.
$\frac{6}{18}$ „ 36.9 „ $8 \times 2.05 = 12.3$ red.
36.9 lbs.

No. 6.—What counts of yarn shall I have to double with 30's to produce 12's?

Apply Rule E., page 46.

$$\frac{30 \times 12}{30 - 12} = \frac{360}{18} = 20\text{'s}$$

Ans. 20's.

No. 7.—A warp of 1035 ends 750 yards weighs 33 lbs. What are the counts?

Rule D., page 72, may be made to apply to this question by changing the terms.

Length $1035 \times 750 = 776250$ yards.
Divide by $840 = 924$ hanks.

$$33\overline{)924}\quad 28$$

Ans. 28's counts.

Honours Grade.—*Same paper.*—**No. 7.**—What will be the relative strain in the shedding of two warps, if one is weaving in a loom running 100 picks per minute, the shed being opened 3 inches each pick, and the other weaving in a loom running 90 picks, the shed being opened 4 inches each pick? the weighting of the warps being the same.

The strain as affected by the size of the shed is in proportion to the amount by which the threads would be lengthened were they perfectly elastic, and this is in proportion to the *square* of the distance that the thread is raised.

The strain caused by the speed is in direct proportion to the speed.

Therefore we compare them by the product of the size of shed squared and the speed.

1st. Lift 3 inches squared = 9 × speed 100 = 900
2nd. „ 4 „ „ = 16 × „ 90 = 1440

$$\frac{900}{1440} = \frac{1}{1.6}$$

The loom with the 4-inch shed has the greater strain in proportion of 1.6 to 1.

No. 14.—Presuming that the relative diameters of cotton yarns are (*inversely*) as the square root of their respective counts, what counts of yarn will give the same firmness in a 2 and 2 twill that 20's would give in a plain cloth, the threads being equal in number both ways?

The question is obviously meant to read as if the word "inversely" were inserted as shown.

Assuming that the opening between the warp threads, where the weft passes through, in interlacing, is about equal to the diameter of the weft, and consequently of the warp, where the same counts are used for warp and weft, then in plain cloth, where the weft interweaves with every end, there will be 4 spaces or intersections for 4 ends of warp; or, in other words, 4 ends occupy a *space* equal to the diameter of 8 ends. If the weave is changed to a 2 and 2 twill, then for each 4 ends, the weft passes once under and once over, or occupies 2 spaces, making the 4 ends of warp to occupy the diameter of 6 threads. If the counts remained the same, the cloth would consequently be more loosely built. To remedy this the yarns

must be made coarser, and the diameter of the new yarn must be to the diameter of the old yarn, as 8 is to 6, these being the relative spaces occupied.

The square root of 20's is 4.47.

4.47 multiplied by 6 and divided by 8 is 3.3525. This is the square root of about $11\frac{1}{4}$'s yarn.

Ans. $11\frac{1}{4}$'s yarn.

No. 17.—How much per yard (grey) will a sateen stripe cost woven to the following particulars:—Brocade stripe of 3 inches, and sateen stripe of 2 inches (in reed) alternate, 40 inches wide in reed, brocade 2 in dent, sateen 4 in dent, twist 40's throughout, 64 reed Stockport, 96 picks per inch 30's weft weaving $\frac{3}{4}$d. per yard. Expenses 10 per cent. more than weaving. Cost of twist in loom $14\frac{1}{2}$d. per lb., weft $9\frac{1}{4}$d.

Apply Rules F., page 23, and D., page 20. Examples given at pages 193 and 198.

Ans. Allow 10 per cent. for contraction in warp and 36 side ends, and nothing for waste beyond what the price allows.

Warp	.1185 lbs.	@ $14\frac{1}{2}$	= 1.72
Weft	.1524 „	@ $9\frac{1}{4}$	= 1.41
Wages	. .	.	= .75
Expenses	. .	.	= .82
	Total	. .	4.7*d.*

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MILES PLATTING REED,

HEALD, AND WIRE WORKS,

VARLEY STREET, OLDHAM ROAD,

MANCHESTER.

HENRY TETLOW,

MAKER OF

ALL KINDS OF REEDS AND HEALDS;

ALSO MAKER OF

SELF-ACTING LOOP AND MAIL HEALD MACHINES,

SELF-ACTING REED MACHINE, 300 DENT PER MINUTE,

PATENT SPACING MOTION FOR HEALD MACHINE,

HEALD BRUSHING MACHINES FOR YARNISHING OR SIZING,

WIRE POLISHING AND ROLLING MACHINES,

DENT CUTTING MACHINES,

STEAM CHEST FOR HEATING PITCH OR YARNISH,

POLISHED WIRE ON RIMS, IN COILS, OR CUT DENTS,

REED ENDS, REED RIBS, REED BAND AND HEALD YARN.

ALL ORDERS PUNCTUALLY ATTENDED TO.

Doubler of all kinds of Cotton Heald Yarn.

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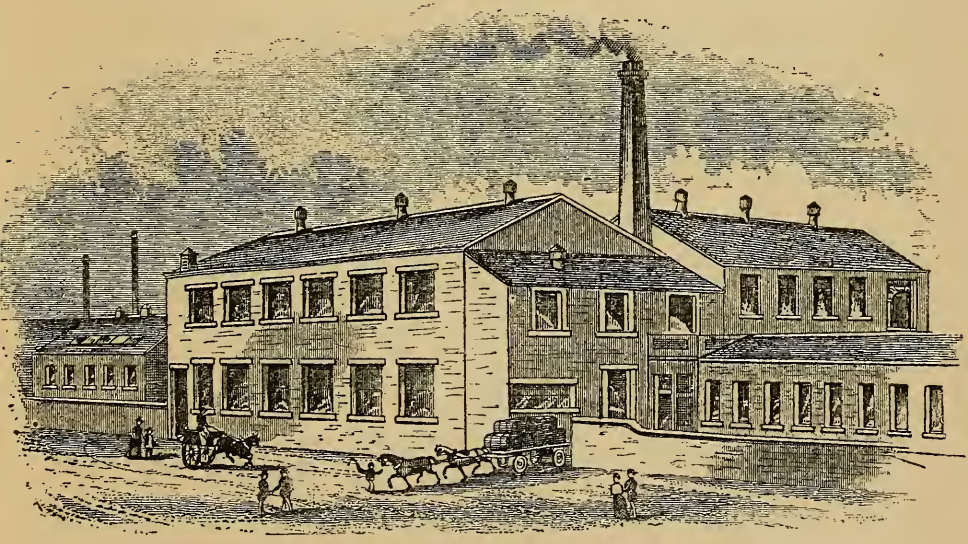

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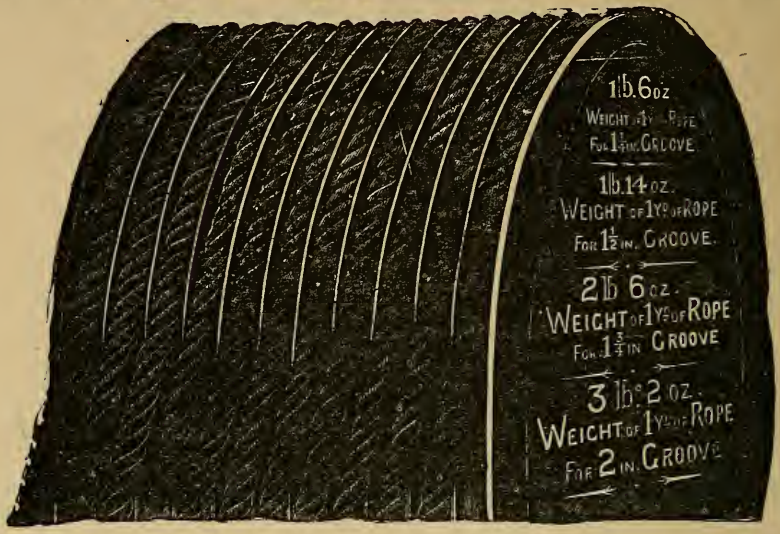

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